

CLASSWIDE PEER TUTORING AND THE ACQUISITION OF ALGEBRA
PROBLEM-SOLVING SKILLS FOR MIDDLE SCHOOL STUDENTS AT RISK OF
MATH FAILURE IN MAINSTREAM GENERAL MATH CLASSES

By

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The purpose of this investigation was to compare the effects of classwide peer tutoring (CWPT) to independent student practice on students' ability to learn algebra problem-solving skills. Effects were measured across time from pretest, which was administered before instruction, through two posttests. The first posttest was administered immediately after instruction and the second posttest was administered 1 week after instruction. The subjects in this study were eighth-grade general math students in three middle schools. The classrooms included students with disabilities and students at risk of math failure.

The procedure for this study consisted of four phases, including teacher inservice, student training, implementation, and posttreatment. Treatment groups (CWPT & independent practice) were determined to have no preexisting

differences. Analysis included the use of a repeated measures 2x2x2 analysis of variance (ANOVA) with treatment group (CWPT & independent practice), student level (at risk & not at risk), and time (pretest & posttest) to determine whether any significant differences were present among the levels of the experimental conditions. Significant differences from pretest to posttest were found for all groups demonstrating that, overall, students significantly improved their algebra problem-solving performance. No significant differences were found from pretest to posttest between treatment groups (CWPT & independent practice) or between at-risk groups (at risk & not at risk). The one exception to this trend between treatment groups was that for students age 14 and 15 those students using CWPT performed better than students using independent practice. No significant differences were found from posttest to maintenance test between treatment groups or at-risk groups, indicating that students in all groups retained what they had learned after 1 week of no algebra instruction. No significant interaction effects were found, meaning performance was not dependent on treatment group, at-risk classification, or any combination of the two variables. Students indicated that they liked using CWPT, while teachers generally liked it, but several teachers complained that CWPT required much teacher energy due to continual monitoring. The results of this investigation provide practical implications for diverse classroom instruction and future research.

CHAPTER I
INTRODUCTION TO THE PROBLEM

Introduction

The verification of effective instructional strategies in mainstream classes is critical if students at risk of failure and students with disabilities are going to be successfully included in general education classes. While several organizations have advocated for inclusion of all students in general education classes (The Association of Persons with Severe Handicaps, 1992; National Association of State Boards of Education, 1992), other professionals question the appropriateness of this action (Fuchs & Fuchs, 1994; Kauffman, 1993). Central to this discussion is whether educational professionals have the instructional technology available to educate adequately students with widely disparate skills in the same classroom (Fuchs & Fuchs, 1988; Fuchs & Fuchs, 1994; Fuchs, Fuchs, Hamlett, Phillips, & Bentz, 1994; Hollowood, Salisbury, Rainforth, & Palombaro, 1994; Kauffman, 1993; McIntosh, Vaughn, Schumm, Haager, & Lee, 1993; Mcleskey, & Pacchiano, 1994; Schumm, Vaughn, Haager, McDowell, Rothlein, Saumell, 1995). Among the instructional strategies which some professionals offer as effective mainstream teaching is peer tutoring (Maheady & Harper, 1987; Maheady, Harper, Mallette, & Winstanley, 1991).

Peer tutoring in various forms has been used in general education for centuries. It is only recently that peer tutoring has been demonstrated to be successful with students who have disabilities or who are at risk of academic failure (Cook, Scruggs, Mastropieri, & Casto, 1985-86; Osguthorpe & Scruggs, 1986; Greenwood, Dinwiddie, Terry, et al., 1984; Warger, 1991). While studies demonstrate that peer tutoring can assist students with disabilities and students at risk of failure to learn academic skills and content, only a few have attempted to determine the effectiveness of peer tutoring with peers of the same class who have widely disparate skills (i.e., classes which include students without disabilities, students with disabilities, and other students who may be at risk of academic failure).

Among the various types of peer tutoring cited in the literature, classwide peer tutoring has been successfully used as an effective instructional practice for peers who tutor each other within the same classroom. The significance of classwide peer tutoring as it relates to inclusive education is that it does not require that tutors from different classrooms come in to tutor or that students who are having difficulty learning in the classroom be pulled out to get tutoring help. Classwide peer tutoring uses students within the same classroom to tutor each other. When systematically implemented, classwide peer tutoring can effectively help the teacher to provide many opportunities

for students to respond to academic tasks and to receive immediate feedback. Two important learning variables verified in the literature are opportunities for multiple numbers of academic responses and frequent feedback about those responses.

Classwide peer tutoring has been demonstrated to help two specific populations of children learn more effectively. Research from the Juniper Gardens Children's Project in Kansas City, Kansas, documents the success of classwide peer tutoring with students at risk of academic failure (Greenwood, Dinwiddie, Terry, et al., 1984). Additional research by several other educational professionals has demonstrated the effectiveness of classwide peer tutoring with students who have disabilities. Primarily, this research has concentrated on elementary age students. The instructional content has predominately been basic in nature including skills such as memorizing math facts, reading sight words, oral reading skills, and spelling. Little research has centered on secondary age students, especially middle school students, or on academic skills which require higher order cognitive thinking (e.g., algebra problem solving).

Statement of the Problem

The problem investigated in this study was the effectiveness of using classwide peer tutoring to assist students at risk of math failure and students not at risk of math failure in mainstream classes to learn and practice

algebra problem-solving skills compared to using traditional individualized practice to assist students at risk of math failure and students not at risk of math failure in mainstream classes to learn and practice algebra problem-solving skills. The experimental questions were as follows:

1. Is there a significant difference between the performance of middle school students who use classwide peer tutoring for learning and practicing higher order cognitive skills (algebra problem solving) and students who use independent worksheet practice for learning and practicing higher order cognitive skills (math problem solving)?

2. Is there a significant difference between the retention of middle school students who use classwide peer tutoring for learning and practicing higher order cognitive skills (algebra problem solving) and students who use independent worksheet practice for learning and practicing higher order cognitive skills (math problem solving)?

3. Is there a significant difference in performance on algebra problem solving between students at risk for math failure and students not at risk for math failure?

4. Is there a significant difference in retention on algebra problem solving between students at risk for math failure and students not at risk for math failure?

5. Are there significant differences in performance on algebra problem solving between four groups: (a) CWPT/at risk, (b) CWPT/not at risk, (c) independent practice/at risk, and (d) independent practice/not at risk?

6. Are there significant differences in retention of algebra problem solving (as measured by a 1-week follow-up test) between four groups: (a) CWPT/at risk, (b) CWPT/not at risk, (c) independent practice/at risk, and (d) independent practice/not at risk?

The problem examined in this study is important for several reasons. First, the study adds to the growing body of research evaluating the effectiveness of CWPT as an instructional tool for mainstream classes. As educators continue to discuss the merits of inclusive education, it will be important to validate instructional procedures which are effective for all students, those at risk of academic failure (including students with disabilities) and students who are not at risk of academic failure. Second, while several studies have found CWPT to be effective in teaching basic academic skills, the literature is sparse in terms of evaluating whether CWPT is effective for teaching higher order cognitive skills. The effectiveness of CWPT in teaching higher order cognitive math skills was investigated in this study. Third, in this study, CWPT was investigated in a middle school setting. During the middle school years, peers can be very influential (Sprinthall & Sprinthall,

1977). During the middle school years, it is important to determine whether instruction using peer interaction can be a positive approach to learning.

Rationale for the Study

Proponents of full inclusion suggest that all students with disabilities can be best served educationally in general education classes (The Association for Persons with Severe Handicaps, 1992; Reynolds, 1988; Reynolds, Wang, & Walberg, 1987; Stainback & Stainback, 1992). Some professionals believe there is sufficient instructional technology to implement full inclusion (Pinnell, Deford, & Lyons, 1984; Stevens, Madden, Slavin, & Farnish, 1987; Wang, 1984; Wang & Zollers, 1990). Other educational professionals believe current instructional technology does not adequately serve all students with disabilities in general education classes (Fuchs & Fuchs, 1988; Fuchs & Fuchs, 1994; Fuchs et al., 1994; Hollowood et al., 1994; Kauffman, 1993; McIntosh et al., 1993; Mcleskey & Pacchiano, 1994; Schumm et al., 1995). Several researchers have examined the effects of classwide peer tutoring in mainstream classes, and their findings suggest that classwide peer tutoring can be effective in helping diverse students improve their academic achievement (Maheady & Harper, 1987; Maheady, Harper, Mallette, & Winstanley, 1991). Positive academic achievement effects have been demonstrated for both students with disabilities as well as students without disabilities at the elementary and

the high school levels. While classwide peer tutoring has been demonstrated to be successful in several mainstream settings, further replication of the academic effects of classwide peer tutoring in integrated classes is necessary to understand more fully the value of classwide peer tutoring as successful inclusive education instruction. Two particular areas which deserve research attention are as follows: (a) Because middle school students have not been the focus of CWPT, it is important to determine whether classwide peer tutoring is an effective instructional strategy for them in mainstream classes, and (b) because classwide peer tutoring has been primarily used to learn and practice basic academic skills such as spelling, oral reading, and math facts, it is important to determine whether classwide peer tutoring can be effectively used by students to learn higher order cognitive skills such as math problem solving.

Scope of the Study

This study was conducted within a limited scope. The delimitations and limitations of this research are described in the following sections.

Delimitations

The study is delimited by geographical location to Marion and Alachua counties, two medium-sized counties in the north central part of the state of Florida. The subjects were 262 middle school eighth grade students in general math classes of which 99 students were identified as being at risk

of math failure and 163 students were identified as not being at risk of math failure. Students were considered at risk of academic failure if they scored a stanine of "3" or less on the 1993-1994 administration of the California Test of Basic Skills (CTBS) or California Achievement Test (CAT), two standardized tests used by the school districts to assess the academic progress of its students. Four math teachers volunteered to participate along with their students in the study. Since students participated within intact classes previously assigned by the school, individual randomized selection of students was not conducted. However, classes were stratified by mean class averages, and then they were randomly assigned to treatment conditions.

Limitations

The results of this study may not be generalized to students at risk of math failure, students with mild disabilities, or students who are not at risk of math failure without systematic replications with these populations. Furthermore, previous experience with word problem solving and the ability levels of the students may limit this investigation. Additionally, the teachers who participated in the study were volunteers, and any biased attitudes they may have brought to the study may also limit this investigation.

Definition of Terms

The following definitions are provided in order to clarify the terms used throughout this study.

Antecedents refers to instructional practices which precede an academic or social response (Mallette, Harper, Maheady, & Dempsey, 1991).

Classwide peer tutoring (CWPT) is an instructional strategy in which students within the same classroom work in pairs to teach each other academic skills. Each student serves as both a tutor and a tutee. One student serves as tutor while the other student serves as the tutee and then after a specified amount of time the two students switch roles. Students follow prescribed tutoring procedures and earn points for academic responding and positive tutoring behavior (Delquadri, Greenwood, Whorton, Carta, & Hall, 1986).

Direct instruction is highly organized teacher instruction which is characterized by high levels of student engagement within academically focused, teacher-directed classrooms using sequenced, structured materials (Mercer, 1992).

Dyads are students who work together in pairs.

Engaged academic time is time a student spends in academically relevant tasks that are moderately difficult (Berliner, Fisher, Filby, & Marlieve, 1979).

Inclusive education occurs when students with disabilities, who are provided appropriate support, are educated in the regular classroom with their peers without disabilities. Inclusive education is used by some professionals to mean an educational system where all students, including students with severe and profound disabilities, are educated in the regular classroom (Stainback & Stainback, 1992). In this study, inclusive education refers to the inclusion of students with mild disabilities (learning disabilities, behavior disorders, and educable mentally retarded) in the regular classroom.

Learning strategies are the techniques, principles, or rules that enable a student to learn to solve problems and to complete tasks independently (Mercer, 1992).

Mainstream comes from the least restrictive environment concept and refers to the practice of integrating students with disabilities socially and instructionally into regular education as much as possible (Mercer, 1992).

Mild disabilities includes students who have learning disabilities, behavior disorders, and who have educable mental disabilities.

Opportunity to respond is the degree to which students have opportunities to respond to academic skill material and tasks. Increased opportunities to respond have been shown to be a critical variable in student learning of academic content (Greenwood, Delquadri, & Hall, 1984).

Peer refers to someone belonging to the same group in society where membership is defined by status (i.e., students in the same school, grade or classroom) (Ehly, 1984).

Peer tutoring is individualized instruction of one student by another (Ehley, 1984).

SES refers to socio-economic status.

Tutee (player) refers to the student who receives instruction, academic prompts, or error correction from the tutor in a tutoring pair.

Summary

The current trend in the literature toward inclusion makes it essential that educators identify effective instructional strategies for more diverse class settings. Research findings indicate that CWPT is effective in helping students at risk of failure, including students with disabilities, to learn academic skills. Several studies indicate that CWPT can be an effective instructional strategy for students in mainstream classes. Further replication of positive findings in mainstream classes is essential to empirically validate CWPT as an effective teaching strategy for integrated settings. It is the intent of this study to contribute information regarding the effectiveness of CWPT in middle school mainstream math classes. Specifically, this study investigates the effectiveness of CWPT in teaching students higher order cognitive skills (algebra problem solving).

Chapter II provides a review and analysis of the relevant literature regarding peer tutoring including its use with students with disabilities, classwide peer tutoring and its use with students at risk of academic failure including students with disabilities, and current issues with math problem-solving instruction. The implications this research has for current mainstream class instruction is also discussed. Chapter III provides a description of the methods and procedures used in this study. Chapter IV presents the results of this investigation. Finally, chapter V presents a discussion of the results as they relate to previous research, implications for instruction in mainstream classes, and recommendations for future research.

CHAPTER II REVIEW OF RELATED LITERATURE

Introduction

Chapter II includes a summary and analysis of the professional literature regarding classwide peer tutoring and students with disabilities. The central focus of this review is the academic effects of classwide peer tutoring for students with disabilities.

This chapter is divided into several sections. Selection criteria for the literature review, a definition of peer tutoring, and a brief historical account of the development of peer tutoring is presented in the first section. The next section includes a discussion of the theoretical base for peer tutoring. The third section provides a description of peer tutoring which includes guidelines for its use. Section four presents a summary of research concerning peer tutoring and students with disabilities. Section five describes classwide peer tutoring and discusses its essential components. The sixth section discusses the importance of increasing students' opportunities to respond, a basic principle of CWPT. Section seven reviews the relevant literature regarding the use of classwide peer tutoring with disadvantaged students and students with disabilities. Section eight provides a summary

of research findings, including implications for future research. The chapter concludes with a brief discussion of current critical issues in math problem solving for students with disabilities.

Selection of Relevant Literature

The initial step in this review of the literature was to determine the criteria for the inclusion of references. All relevant studies from the last 10 years (1983-1993) were examined. Additionally, any research published before 1983 was also considered.

To be included in this review, professional literature concerning classwide peer tutoring was required to meet the following criteria:

1. The subjects and settings were thoroughly described.
2. The descriptions of the treatment conditions and experimental procedures were detailed enough to permit replication.
3. The experimental design and analysis procedures were thoroughly described.
4. The interpretations were consistent with the results displayed.

References were obtained through the library services at the University of Florida or through other professionals in the field. Descriptors used in this literature search included peer tutoring, classwide peer tutoring, special

education, students with disabilities, students with handicaps, and various authors' names based on their prominence in the field.

The initial references were reviewed according to the previously described criteria. Those describing empirical investigations were chosen if the studies provided a clear description of subject selection, methodology, and results. Professional literature other than empirical investigations were also included if the information presented provided knowledge which was pertinent to the topic of peer tutoring or classwide peer tutoring.

Definition and Historical Development of Peer Tutoring

Peer tutoring is an instructional system in which learners help each other learn (Goodlad & Hirst, 1989). Ehley (1984) described peer tutoring as the individualized instruction of one student by another. In this discussion, peer is defined as someone belonging to the same group in society where membership is defined by status.

Principally, this discussion focuses on peer tutoring as it relates to the school environment and the students who interact within this environment. In public schools, peer tutoring occurs when one student assists another student in learning and practicing a skill or task.

Accounts of cross-age and peer tutoring date back to the first century AD. In the modern era, peer tutoring was formally introduced in the late 18th century by Joseph

Lancaster and Andrew Bell (Goodlad & Hirst, 1989).

Throughout American history, older students in one-room school houses often helped younger students with their school work. More recently, programs which were developed in the 1960s and which used the child-helping-child concept were more systematically implemented on a large-scale basis. Large school systems were among the first to institute peer tutoring programs with children in regular classrooms. Mobilization of Youth in New York City was one such project. In this project, older students tutored younger students in reading. The project reported gains for both learners and tutors (Ehley, 1984). Peer tutoring has been rediscovered in recent years and has been used in a variety of ways (Goodlad & Hirst, 1989). These approaches include students teaching their peers, older students teaching younger students, nonprofessional adults teaching other adults, students without disabilities teaching children with disabilities, and students with disabilities teaching students without disabilities.

Theoretical Base for Peer Tutoring

The theoretical foundation for classwide peer tutoring is comprised of principles derived from several strong literature bases. These literature bases include research in the areas of learning theory, social learning theory. Additionally, current research which supports the instructional principles of CWPT is discussed.

Behavioral Learning Theory

Toward the end of the 19th century, a dualistic view of learning was held by most philosophers and theologians (Bolles, 1979). Basically, it was thought that animals and humans learned differently. Human learning was an intellectual process involving ideas, appreciation of experience, and an awareness of logical relations, while animal learning was primarily reflexive and instinctual. Edward L. Thorndike disputed this dualistic interpretation of learning (Bolles, 1979). Thorndike hypothesized that both humans and animals learned by forming associations between stimuli and responses. According to Thorndike, behavior was not a product of the central nervous system, and the nerve cell was not the basic unit for describing behavior. Instead it was the stimulus-response connection which comprised the basic unit of behavior. Thorndike proposed that all learning involved the formation of stimulus-response connections. This hypothesis concerning stimulus-response connections became the foundation for later developments in learning theory. Additionally, Thorndike also developed the concept of reinforcement. Before Thorndike, human learning was thought to be comprised of simply the gathering of experience. But Thorndike posited that learning occurs when a response is associated with a satisfying state of affairs (Bolles, 1979).

Another prominent psychologist who was instrumental in the development of behavior theory was John B. Watson. Watson proposed that when a stimulus and a response occur at the same time, the connection between them is strengthened (Watson, 1957). The strength of the connection is dependent upon the frequency with which the stimulus and the response occurred together. Watson refuted the notion of reinforcement. He believed instead that a stimulus produces activity in a certain part of the brain and the response produces activity in another part of the brain. When these two areas are activated together, then the neural pathways between them are strengthened (Watson, 1957). Actually Watson's theory of learning was a protest against Thorndike's, whose ideas about reinforcement were too mentalistic in nature for Watson (Bolles, 1979; Watson, 1957).

Burrhus Frederick Skinner was a third influential figure in the development of behavior theory. He also believed that the stimulus-response connection was the key to learning. Skinner concluded that the basic datum for the student of behavior was an observed correlation between stimulus and response (Skinner, 1974). He avoided trying to find underlying mechanisms of behavior but instead believed the focus should be on observing behavior and designing experimental conditions that would make our observations more lawful and orderly (Bolles, 1979; Skinner, 1974). Skinner

was the first to conceive of operant conditioning, the process by which a response when closely followed by a positive reinforcer becomes more likely to occur again. Using the Skinner box, Skinner clearly showed the powerful effect of reinforcers to shape behavior in rats. Skinner's conception of reinforcement differed from that of Thorndike in that controlling behavior was the important consequence, not the production of stimulus-response connections, habits, or expectancies (Bolles, 1979). "Reinforcers are simply events that increase the rate of responding" (Bolles, 1979, p. 121). Skinner generally believed that all behavior was controlled by its consequences. We could control behavior by controlling consequences in appropriate ways. According to Skinner, we could make particular behaviors occur if we wanted or make particular behaviors not occur. The appeal of operant conditioning to many educators is its application to the practical problems of behavior management.

The general principles of behavioral learning theory are more recently viewed through stages of learning (Mercer, 1992). Smith (1981) presented the stages of learning that are commonly recognized. The *acquisition* stage of learning occurs when the learners' performance ranges from 0 percent accuracy to a 90% to 100% range of accuracy. During this stage, teacher instruction should concentrate on assisting the student to perform the skill accurately. Important teaching strategies to include during this stage of learning

include physical guidance, shaping, demonstration, modeling, and cueing and prompting.

The *proficiency stage* of learning occurs when the learner learns the skill at an automatic level. The student begins to perform the skill accurately and quickly. Increasing speed of performance is the instructional focus of this stage of learning. Learning at the proficiency stage is enhanced by such instructional strategies as modeling, setting expectations, drill, positive reinforcement, and manipulation of reinforcement schedules.

The *maintenance stage* occurs after high levels of learning have developed. The goal of instruction for this stage of learning is to maintain a high level of performance. Periodic practice is necessary to maintain this high level of performance. Students with learning problems often have difficulty at this stage because it requires retention (memory) of the skill. Maintenance and memory are enhanced instructionally by overlearning, intermittent schedules of reinforcement, social reinforcement, and intrinsic reinforcement (self-management).

The *generalization stage* of learning is characterized by the student's ability to perform the skill in different times and situations (e.g., in different classes, at home, on the job). Instructional strategies for enhancing generalization include varying training models, gradually loosening control of environmental factors while teaching students (varying

instruction, stimuli, and reinforcers), and teaching the student to self-monitor behavior (Stokes & Baer, 1977; Wildman & Wildman, 1975).

The last stage of learning outlined by Smith (1981) is the *adaption stage*. In this stage, the learner applies a previously learned skill in a new area of application without benefit of direct instruction or guidance. Strike (1975) suggested that a discovery method of learning might be useful in developing adaption skills. It should be noted that adaption is not taught often and is a particularly difficult stage of learning for students with learning problems to attain (Mercer, 1992).

Behavior Theory and Classwide Peer Tutoring

Two learning theory principles which peer tutoring employs are immediate reinforcement and group contingencies. Skinner demonstrated through his work with schedules of reinforcement that the closer a reinforcer occurred to the behavior, the stronger the probability that the behavior would occur again (Bolles, 1979). "One of the central principles of applied science of education is that children's behaviors, be they academic performances or social interactions, tend to occur more predictably when they are reinforced by immediate consequences " (Gerber & Kauffman, 1981, p. 169). Whether reinforcement derives from a teacher or a peer, the probability of that same response occurring in the next similar circumstance increases (Gerber & Kauffman,

1981). A large amount of research over the past 15 years suggests the potency of reinforcement coming from children's peers (McGee, Kauffman, & Nussen, 1977). Immediate reinforcement occurs in peer tutoring through the awarding of points immediately after a peer makes a target skill response. The teacher may also offer immediate reinforcement by awarding points to individual students for appropriate tutoring behaviors as the teacher monitors the peer tutoring teams.

Group contingencies, referring to the tangible and social rewards that an individual receives based upon some measure of the performance of their group, is a second principle of classwide peer tutoring which is derived from the concept of reinforcement (Gerber & Kauffman, 1981). Peer tutoring uses group contingencies to reinforce the academic and social behaviors of individual students by contributing individual point totals to a total team score. Individual points are earned based on accurate academic and social responses during tutoring sessions. Teams are comprised of a number of individuals within a classroom. Team scores are then compared to determine a winner, and the team with the highest point total is usually rewarded as "Team of the Week." Research by Buckholdt and Wodarski (1978) indicated that specific structures of group contingencies (e.g., contingencies based upon the average performance of the group, the average of the highest performances, or the

average of the lowest performances) can promote and maintain tutoring and helping behaviors among children in classrooms. Although the academic output of children varied under different contingencies in this study, the frequency of peer tutoring interactions increased. Hamblin, Hathaway, and Wodarski (1971) demonstrated that manipulation of group contingencies can increase individual academic performance in inner-city schools where large numbers of students are underachieving.

Through the use of individual and group reinforcement techniques, peer tutoring incorporates two instructional procedures well substantiated in the literature to be effective. The power of these elements have been repeatedly demonstrated when used in conjunction with peer tutoring (Gerber & Kauffman, 1981).

Many more recent researchers have demonstrated the effectiveness of reinforcement for improving academic performance (Nelson & Polsgrove, 1984). However, several authorities suggest that reinforcement alone is not always successful in improving academic skills (Ayllon & Azrin, 1964; Smith & Lovitt, 1976). The entry level of the student can be an important factor when reinforcement alone is unsuccessful (Mercer, 1992). For example, Smith and Lovitt (1976) found that reinforcement was not effective when students were learning to solve computational math problems but was successful in increasing computational fluency during

practice. Because CWPT occurs after teacher instruction and during student practice, the reinforcement techniques within CWPT should match the entry level of most students in the study.

Social Learning Theory

Social learning theory as described by Vygotsky (1978) also supports the use of peer tutoring as an effective instructional approach. Peer tutoring is a type of group instruction in which two students benefit from the social interaction that results from the tutoring structure. Based on the students' need to internalize their instruction through communication with others, Vygotsky views learning and development as mediated through social interaction (Conway & Gow, 1988). "What children can do with assistance of others might be in some sense even more indicative of their mental development than what they can do alone" (Vygotsky, 1978, p. 85). Vygotsky's view is illustrated through the concept of "zone of proximal development." Vygotsky uses this term to describe the distance between the performance level of a student while learning alone and the performance level they could reach if they were aided by a teacher (usually an adult but a student tutor can also take this role). To begin, the proximal zone of development is small, but as the student works with another person, the student's proximal zone of development is expanded. During this process, the student gradually takes on more of the

learning task as they acquire more skills. The teacher or tutor correspondingly relinquishes his/her responsibility for performing the task as the student acquires the necessary skills to perform the target skill. The teacher or tutor then takes on a supportive role, only helping when the student requires assistance. The student enlarges his/her zone of proximal development by taking on a self-regulative and self-interrogative role (Conway & Gow, 1988).

In peer tutoring, the tutor serves as the "teacher" or "expert" and helps to facilitate the learning development of the tutee. At first, the tutor provides much assistance to the tutee, but as the tutee increases his/her skills, the tutee requires less help from the tutor. Eventually, through the reciprocal interaction between tutor and tutee, the tutee successfully learns the target skill. In this way, peer tutoring uses social interaction as a method for assisting students to learn.

Current Research Supporting Instructional Principles of Classwide Peer Tutoring

The findings in two current research bases also support the instructional principles used in classwide peer tutoring. Research that focuses on effective classroom instructional principles supports the use of several key instructional principles: individualization, modeling, motivation, similarity of instructor to student, and academic engaged time. Additionally, research that focuses on cooperative learning also supports several principles of instruction used

in classwide peer tutoring: cooperative incentive and task structures.

Principles of effective instruction. Several peer tutoring principles derive from another body of literature, that of effective instructional practices. Cohen (1986) identified individualization, modeling, motivation, and similarity as four components of effective instruction which advance learning in tutors and tutees. The one-to-one ratio achieved with tutor/tutee pairings maximizes the active participation of learners, which, according to Piaget's findings, improves comprehension and the development of cognitive-organizational skills (Cohen, 1986). The individualized nature of peer tutoring can improve the traditional classroom setting by offering constant attention, explanation, demonstration, and direct and immediate feedback and reinforcement of tutee's questions and responses. Additionally, individualization adjusts the learning experience to the level and pace of the individual tutee (Cohen, 1986).

Modeling is a second effective instructional practice which peer tutoring employs. Bronfenbrenner (1970) compared children in the U.S. with children in the former U.S.S.R. and determined that American children were more likely to look to their peers as models than were Soviet children. Barry and Overman (1977) found that peer models were more effective than adult models. Modeling occurs in peer tutoring since

the tutor can describe and perform the target skill for the tutee. Also, when a reciprocal tutoring format is used, each student in a tutoring pair serves as a model to the other.

Cohen (1986) suggested that the motivational system of peer tutoring involves tangible, social, academic, and moral reinforcements. Tangible rewards such as stickers and pencils can be given for correct responses during tutoring or for group achievement. Social motivation can be obtained by the tutee through the attention and verbal reinforcement of the tutor. The tutor is reinforced through social contact, social verbal and nonverbal reinforcement, the communication and attention of the tutee, and the perceived high status of their interaction with the tutee. A last source of motivation is the academic achievement and status achieved outside of the peer tutoring process in the form of academic gain possibilities in other class material or in other classes.

A last characteristic of peer tutoring identified by Cohen (1986) which results in effective instructional practice is the similarity between the person delivering the instruction and the person receiving the instruction. The closeness of a peer as teacher (compared to an adult) is unique to peer tutoring and offers several instructional advantages. The potency of the peer as a social reinforcer has previously been discussed in regard to motivation. Also, the peer may be better equipped than an adult to present

subject content in a way which is best understood by the learner because of their greater familiarity with the tutee's cognitive framework. Common peer language and gestures may also create better communication between tutor and tutee than would occur between child and adult. Cohen (1986) suggested that these factors, among others, contribute to the tutee's being more comfortable with the peer tutor, resulting in greater learning by the tutee.

Myers, Travers, and Sanford (1965) found peer tutoring to be superior to students studying alone, suggesting that peer interaction may significantly impact the individualization factor in peer tutoring. Jenkins, Mayhall, Peschka, and Jenkins (1974) reported that peer tutoring was more effective than small group instruction or studying alone, lending support to the idea that individualization, feedback, and social reinforcement provided by the peer were very important in maximizing achievement gains.

High levels of academic engaged time is another effective instruction principle substantiated in the literature (Berliner, 1988). Berliner et al. (1979) described academic engaged time as the time a student spends in academically relevant tasks that are moderately difficult. Rosenshine and Berliner (1978) reported that time spent engaged in relevant content is "an essential variable for which there is no substitute" (p. 12). Academic engaged time has been consistently demonstrated to correlate positively

with academic achievement (Greenwood, Dinwiddie, Terry, et al., 1984; Rosenshine & Stevens, 1986).

The type of instruction delivered and classroom ecology is highly related to the level of student engagement (Greenwood, 1991a). For example, classrooms in which teachers stand up in front of the class and lecture produce large amounts of passive attention from students (Greenwood, Dinwiddie, Terry, et al. (1984). Group instruction limits the amount of academic engaged time for many students since the pace of instruction is not optimal for many students. Because instruction is directed at the group, invariably the pace will be too slow for some and too fast for others. This situation necessitates that these students will be either forced to wait until their peer group attains adequate performance (if the pace is too slow) or students will be forced to move ahead before they achieve mastery (if the pace is too fast). In either case, the student will not be involved in high levels of academically engaged time (Jenkins & Jenkins, 1985). Therefore, group instruction will produce less than optimal rates of progress. Rosenshine and Berliner (1978) contended that one of the most important skills a teacher can possess is the ability to arrange sufficient content coverage as well as a sufficient number of academic engaged minutes per day.

High levels of academic engaged time is a key feature of peer tutoring. In peer tutoring formats, the focus is on

students making many relevant academic responses. Because peer tutoring creates a one-to-one instructional relationship between the tutor and tutee, high levels of responding are possible. With only two students working together, more time is available for individual academic responding.

Cooperative learning. Cooperative learning is a group instruction method which has been extensively researched, and this literature verifies the positive benefits of several concepts which peer tutoring employs. Although there are several different cooperative learning methods, all are united in their use of the basic principles of cooperative incentive and task structures to achieve cognitive as well as noncognitive goals in typical classrooms (Slavin, 1983). Students work together in small groups to complete particular academic tasks, and then they receive recognition, rewards, or grades based on the academic performance of their group. Slavin defines cooperative behavior as the "actual participation and coordination of efforts between two or more individuals" (p. 4). The main feature of cooperative behavior is that each cooperator facilitates the task performance or goal attainment of the other cooperators. Communication between cooperators is very important. Slavin (1983) reported that the alternatives to cooperative behavior are individualistic behavior, where persons work independently, and competitive behavior, where persons try to impede the progress or performance of others. Slavin (1983)

summarized the large amount of research supporting cooperative learning by stating that cooperation has the potential for improving the performance of students, increasing their mutual attraction, and increasing their self-esteem.

Peer tutoring uses the two cooperative learning components of task structures and incentive structures. Cooperative task structures are academic or social tasks in which students are allowed, encouraged, or required to work together on some task. Peer tutoring encourages the cooperation of two students to help each other learn particular content or target skills. Cooperative incentive structure is used when two or more individuals are in a situation where the performance of one affects the degree to which others are rewarded. Peer tutors and tutees can earn points as they make accurate academic or social responses, and their points can be added to the points of other students to make a team total. All individuals, then, are rewarded based on the entire team's performance. Cooperative incentive structure benefits from the reinforcement principles of group contingencies discussed earlier in this paper in relation to learning theory.

Description and Guidelines of Tutoring

After discussing the theoretical and research support for using classwide peer tutoring as an instructional strategy, the discussion will now move to describing the

guidelines that shape the implementation of a peer-tutoring system. Mercer and Mercer (1993) described "best practices" in implementing a peer-tutoring system. Several factors should be considered when developing a peer-tutoring instructional format in the classroom. First, goals should be established for the peer-tutoring program. Examples of peer-tutoring goals might be providing students with an opportunity to practice and learn targeted academic skills, providing tutees with an opportunity to review and learn subject content, and providing tutors and tutees with the opportunity to develop appropriate social skills.

A second guideline for implementing peer tutoring is how to determine appropriate target skills and content for tutoring pairs. Basically, the content or target skills should be presented by the teacher before tutoring begins. Several research findings guide the teacher in choosing appropriate content. First, peer tutoring has been found to be effective in most academic areas. Second, gains in math have been greater than gains in other academic areas. Third, peer tutoring seems to work best for working on low-level skills (e.g., spelling words or math facts). Fourth, peer tutoring appears to work better for molar-level activities such as number of words written or read correctly as opposed to singular skill activities such as decoding skills. Fifth, targeted skills should be similar to those used in the classroom. Last, gains are more likely to be evident with

curriculum-based assessment measures rather than standardized measures (Mercer & Mercer, 1993).

A third guideline for peer tutoring outlined by Mercer and Mercer (1993) involves the selection of materials. Most peer-tutoring programs should include the following: (a) directions for tutor and tutee, (b) academic tasks presented on flash cards, worksheets, or pages in a textbook, (c) an assessment sheet for the tutor to record correct and incorrect responses, and (d) scoring procedures if tutee performance is to be evaluated.

A fourth consideration in implementing peer tutoring is to design procedures for the tutor and the tutee. These procedures should include instructions on how the tutor should present the academic task to the tutee, how to provide feedback for correct and incorrect responses, and how to record and total the performance score of the tutee. The procedures also instruct the tutee how to respond to the academic task (e.g., in writing, verbally). Last, procedures should inform the tutor and tutee of rewards contingent on the achievement of specified goals.

A fifth major consideration for peer-tutoring implementation emphasized by Mercer and Mercer (1993) is the assignment of tutor-tutee pairs. Several different tutor-tutee arrangements can be used. Across-class tutoring involves students from one class going to another class to tutor. Usually this involves an older or higher achieving

student serving as tutor. Pull-out tutoring involves the tutee going to a specialized work setting to work with a tutor from another class. A third type of tutoring is intraclass tutoring, which involves students from the same class serving as both tutors and tutees for each other. Tutoring may be either one-way or reciprocal. One-way tutoring involves one student who always serves as tutor and one student who always serves as tutee. In reciprocal tutoring, each student in the tutoring pair serves as both tutor and tutee.

Training tutors is a sixth important area which should be considered when implementing a peer-tutoring program. Mercer and Mercer (1993) maintained that tutor training should include a combination of the following: (a) orientation to the rationale and goals of tutoring, (b) a description of the materials and procedures, (c) teacher demonstration of tutoring skills, (d) tutor imitation and role-playing procedures with feedback, (e) intermittent guidance when needed, and (f) praise for following the procedures correctly. Mercer and Mercer (1993) suggested that tutor training should be conducted through the direct instruction sequence (use an advanced organizer, describe the behavioral expectations, demonstrate the behavioral expectations, conduct guided practice with feedback, conduct independent practice with feedback, and provide maintenance instruction).

Training tutees is a seventh important task when coordinating a peer-tutoring program. The primary task of the tutee is to try his/her best. More specific duties include following directions, receiving feedback appropriately, and maintaining attention. As with tutors, Mercer and Mercer (1993) suggested that tutees should be trained in the direct instruction sequence described previously.

Teaching social skills used in peer tutoring and reviewing rules are the eighth and ninth important tasks suggested by Mercer and Mercer (1993) for the peer-tutoring instructor. Teaching several key social skills, such as accepting a partner, giving and accepting corrective feedback, and praising a partner, help to provide a positive and supportive environment in which to work. Standard classroom rules should apply when peer tutoring is in progress and two specific rules, "making transitions quickly" and "use whisper voices," especially should be stressed.

A 10th important consideration for peer-tutoring development is how to schedule peer-tutoring sessions. Generally, peer-tutoring sessions occur for 20 minutes for one-way peer tutoring and 30 minutes for reciprocal peer tutoring. Two or more sessions weekly provide the most positive results.

Supervising the peer-tutoring sessions is an 11th important task that should be considered by the teacher when

implementing a peer-tutoring program. Once the students have become proficient in their respective tutor-tutee roles, teachers can monitor the sessions by scanning the room when working with student-tutoring pairs and periodically meeting with tutoring pairs to discuss their progress. The use of performance contingencies (positive reinforcement for individual or group performance) also can positively affect maintenance of effective peer-tutoring behaviors.

The last important task that Mercer and Mercer (1993) stressed for implementing a peer-tutoring program is the evaluation of the program. Evaluation can be accomplished through daily performance progress sheets which are completed by the tutor. Additionally, weekly quizzes on the skills or content covered in peer tutoring can be helpful in determining progress of students.

Peer Tutoring and Students with Disabilities

Within the history of peer tutoring, this instructional strategy has been used successfully with the general student population. Goodlad and Hirst (1989) reported the substantial cognitive and affective benefits of peer tutoring with general education students; however, it is not within the scope of this study to address these many interesting reports. Primarily, this study discusses peer tutoring as it relates to students with disabilities.

Although accounts of peer tutoring can be traced to the first century AD, it is only recently that the use of peer

tutoring has been applied to students with disabilities (Osguthorpe & Scruggs, 1990). The use of peer tutoring as an instructional strategy for students with disabilities has proven quite productive. A substantial amount of research validates the effectiveness of peer tutoring in producing both academic and social gains for students with disabilities (Warger, 1991). Improved academic and social outcomes are reported for both the tutor as well as the tutee (Cook et al., 1985-86). Moreover, researchers have demonstrated that peer tutoring is effective when students with various disabilities are involved. Positive effects have been reported for students with mental retardation (Eiserman, Shisler, & Osguthorpe, 1987; Mallette et al., 1991; Shafer, Egel, & Neef, 1984; Vacc & Cannon, 1991), students with behavioral disorders (Scruggs, Mastropieri, & Richter, 1985), and students with learning disabilities (Beirne-Smith, 1991; Scruggs & Richter, 1985).

Several research syntheses confirm the productivity of peer tutoring and students with disabilities. Cook et al. (1985-86) conducted a meta-analysis of 17 studies where students with various disabilities served as tutors. Significant mean effect sizes were found for both tutors and tutees (.59 & .65, respectively) in reading, math, and language arts. Mean effect sizes for measures of attitudes toward school, academic content, and other students was higher for tutees (.86) than for tutors (.25). Significant

changes in self-concept and sociometric measures were not found. Whereas academic gains for students with disabilities involved in peer tutoring are substantiated, the authors cautioned against assuming the legitimacy of generalized social benefits. Attitudes improvement seems to be present with peer tutoring, but more global measures of social functioning such as self-esteem and sociometric ratings indicate that peer tutoring has no effect on these variables. The attitudes of students toward school and the content area tutored seem to improve with tutoring. Cook et al. (1985-86) concluded that more attention must be given to self-esteem in research. and more evidence must be reported before it can be assumed that significant effects on self-esteem result from peer tutoring.

In another research review of peer tutoring and students with disabilities, Osguthorpe and Scruggs (1986) reported academic and social outcomes improvement. Of the 26 studies reviewed, 23 reported that tutors and/or tutees performed better on outcome measures during tutoring. Only three studies reported finding no treatment effects. Although the authors reported positive findings, they stressed that peer tutoring has not been found to be effective with some social variables, particularly self-esteem. The authors did not discount that peer tutoring might be effective in improving students' self-esteem; they maintained that methodological problems may have negated possible effects. For example, the

authors cited a particular study (Top, 1984) which did not find growth in self-esteem. Top (1984) concluded that the reason improved self-esteem was not found was because students' pretest data were so positive that there was little room for improvement.

Warger (1991) also analyzed the effects of peer tutoring and students with disabilities. Warger's analysis of the literature is quite similar to the researchers previously mentioned. Positive academic effects are cited, and an emphasis is placed on the success peer tutoring has with tutors who have disabilities. Social benefits which are cited by Warger (1991) include improved attitudes toward students with disabilities and increased positive interactions between peers with disabilities and their nondisabled peers during free play. Warger (1991) also emphasized that peer-tutoring effects on self-esteem are uncertain.

In summarizing the conclusions reached by researchers regarding the efficacy of peer tutoring and students with disabilities, several statements can be made. Academic gains by students with disabilities are evident. These gains have been found for both tutors and tutees. Social benefits which are directly related to the tutoring process (e.g., attitudes and social interaction with tutor and tutee) also have been clearly demonstrated. Positive effects on self-esteem have not been established. Last, effective tutoring programs must

be systematically applied and carefully planned, with attention paid to such things as the needs of the tutors and tutees, the time and effort to train tutors, and the time and effort required for the actual tutoring process (Osguthorpe & Scruggs, 1986).

Description of Classwide Peer Tutoring

The literature which discusses the effects of peer tutoring and students with disabilities primarily represents two different peer-tutoring formats: cross-age peer tutoring and same-age peer tutoring. The large majority of peer-tutoring studies incorporate a cross-age peer-tutoring format (Ehly, 1984). In such a format, the older student who is at a higher grade level serve as tutor to his/her younger partner.

The predominate use of cross-age peer tutoring makes sense because it is usually assumed that the older student is competent in the skills that the younger student needs to learn. A problem this presents to the classroom teacher, whose students are of similar age, is that to incorporate a large-scale, cross-age peer-tutoring program, the teacher has to arrange for older students to come to his/her room or to have his/her students go to another room supervised by another teacher. Such a situation can cause immense scheduling problems, and, in the latter instance, the teacher relinquishes control and direct supervision of his/her students.

Classwide peer tutoring solves these problems because all tutoring occurs within the same classroom. In this situation, scheduling problems are eliminated, and the teacher does not lose direct supervision of his/her students. Classwide peer tutoring is especially useful for instruction in integrated classrooms which include both students with disabilities and students without disabilities. A potential problem for students with disabilities during peer tutoring is that they are usually identified as students who are of lower ability and who need tutoring help. This stigma is only heightened when they have to leave the room for tutoring or when another student comes into the disabled student's room to work with him/her individually. Classwide peer tutoring is less stigmatizing since all students within the same classroom tutor each other.

Classwide Peer Tutoring (CWPT) is a systematic instructional strategy which involves all students within a classroom. The teacher defines the academic task to be learned and systematically trains the students to use the appropriate tutoring behaviors necessary for learning the academic skill (Delquadri et al., 1986). During CWPT each student serves as both the tutor as well as the tutee. The class is divided into two teams with each team composed of peer dyads (tutoring pairs). The goal of each dyad is for the students to teach each other the particular academic skill. An additional goal of the dyads is for each student

to practice the academic skill and in turn monitor his/her partner's academic responding.

Points are assigned individually based on each student's responding and tutoring behaviors. The tutor in the dyad assigns points to the tutee based on the tutee's correct responses and their error corrections. The teacher may assign additional points to students who exhibit appropriate tutoring behaviors (i.e., cooperative work habits, accurate point recording, following directions). The CWPT sessions usually last approximately 30 minutes and occur 2 to 4 days a week. A typical session consists of 10 minutes for each tutee in the pair and 10 minutes for point recording and totaling. After individual points are totaled by each student in the tutoring pairs, the teacher assigns the points to the appropriate team. The teacher then posts the team scores in the classroom. Individual point totals can also be posted if desired (Delquadri et al., 1986).

Students take tests periodically, typically once every week, to ascertain each student's progress in mastering the academic skill. Points are awarded for each correct answer, and these points are added to the team total. Following the quiz, students on the team with the most points for that week are rewarded in some way, typically by distributing to them "Team of the Week" certificates.

Essential Components of CWPT

Classwide peer tutoring is composed of six essential components including frequent feedback, systematic training of both the tutor and the tutee, precise implementation, teacher/student reinforcement, peer-mediated contingencies, and teacher/student responsibility (Hall, Delquadri, Greenwood, & Thurston, 1982; Maheady, Sacca, & Harper, 1987). Frequent feedback occurs in CWPT since the procedure specifically requires the tutor to tell the tutee whether his/her response is correct or incorrect. The tutor also records points for each response which also provides feedback to the tutee. Finally, when the tutee responds incorrectly, the tutor tells the tutee the correct answer and monitors the tutee's error correction response (e.g., rewriting the response three times).

Systematic training occurs when the teacher precisely describes the correct tutoring procedures to the students. Second, the teacher models the described behavior. Third, guided and independent practice of the tutoring procedure occurs. Last, the teacher monitors student-tutoring behaviors during tutoring practice.

Precise implementation is ensured through teacher monitoring. Throughout the CWPT process, the teacher continually monitors each student dyad. The teacher awards points to students for correct tutoring behaviors and also

corrects tutoring errors as necessary during the tutoring sessions.

Teacher/student reinforcement occurs because the teacher awards points while monitoring the student dyads. Teachers also reinforce students when posting team point totals and by awarding certificates to the "Team of the Week."

Classwide peer tutoring incorporates peer-mediated contingencies by allowing students to reinforce each other within the tutoring dyad. Since tutors monitor tutee responses and assign points based on these responses, each student peer is an active part of the reinforcement schedule.

Finally, the teachers and the students take responsibility throughout the learning process. Teachers assume responsibility through the active training of students as tutors and tutees, through monitoring students during the tutoring process, and by adjusting the tutoring curriculum based on both individual student progress as well as total class progress. Students become responsible participants in the tutoring process since they are actively involved in both the learning and the teaching of the academic content. Students are accountable for their learning progress via point accumulations during tutoring and scores on weekly tests. Students also assume responsibility because they are the primary teacher and progress monitor of their partner during the tutoring process. This additional duty as

"teacher" requires students to take an active role in the learning process.

Increasing Students' Opportunities to Respond--A Basic Principle of CWPT

The principle of opportunity to respond is the primary foundation of CWPT (Hall et al., 1982). Opportunity to respond is defined as "the interaction between (a) teacher-formulated instructional antecedent stimuli (the materials presented, prompts, questions asked, signals to respond, etc.) and (b) the success of these antecedents in establishing the academic responding desired or implied by the materials" (Mallette et al., 1991, p. 156). Opportunity to respond refers to the interaction that occurs between instruction (whether by teacher or by tutor as in peer tutoring) and student (tutee in peer tutoring) responding (Maheady & Harper, 1987). The number of responses a student makes to an academic task is an important determiner in that student's acquisition and retention of the target content or skill. Researchers have found that the ability of students to learn academic material varies as a function of how well the classroom is structured to permit active interaction with the materials and academic tasks (Maheady & Harper, 1987). Various researchers reported that in those environments in which students actively participate with academic tasks directly related to target skill acquisition, receive immediate feedback on their performance, and are frequently tested for retention, these students' learning appears to be

maximized. In classrooms where opportunities to respond are few, academic achievement decreases (Delquadri, Greenwood, Stretton, & Hall, 1983; Hall et al., 1982).

Studies conducted by Charles R. Greenwood and his colleagues at the Juniper Gardens Children's Project in Kansas City, Kansas, serve as the foundation for the principle of opportunity to respond. Through the research of Greenwood and his colleagues with inner-city children, it became apparent that the main factor in the academic failures of many inner-city children was the lack of response opportunities for these children (Hall et al., 1982). While the failure of the children at Juniper Gardens had been previously blamed on lack of student motivation and faulty curriculum materials, the researchers at Juniper Gardens found that the major factor for these children's failure was the lack of opportunity for these children to make active learning responses in their environments.

The lack of response opportunities for these inner-city children are due to several factors according to Hall et al. (1982). First, the environment in which these children live is less enriched than their middle-class counterparts (fewer books, magazines, educational games, and toys). Additionally, the level of schooling and the number of reading adults in this environment are also lower than their counterpart middle-income environments. These factors interact to create a home environment which limits active

opportunities for these children to respond to academic material and content. Greenwood and his colleagues have demonstrated that simple procedures can be carried out by parents to increase the opportunities for their children to practice reading, math, and spelling skills (see Hall et al., 1982, for further discussion).

Several reasons for low academic response rates in classrooms are outlined by Hall et al. (1982). First, teachers may not be aware of the need for increased responding rates for their students. Teachers structure their classes so that most of the time is devoted to teacher activities such as lecturing, explaining, and giving instructions. Time used for transitions from one subject to another also subtracts from the time students could be responding actively to academic content and materials.

Second, inappropriate teacher training and noninstructional teacher demands hinder teachers from providing response opportunities in their classrooms. Emphasis in teacher-preparation programs is placed on effective lesson preparation and presentation, appropriate curriculum materials, and making sufficient progress through material during the year. Because of increasing numbers of school district requirements and timelines which require teachers to cover more material without increasing the amount of instructional time, teachers are forced to forsake active student responding. Instead, teachers present material in

lecture form, where students sit independently with little teacher-student interaction, stress major points, and progress rapidly through the curriculum.

A third reason for low academic response rates in classrooms offered by Hall et al. (1982) is the proposition that having students increase their responding rates may be punishing to teachers, parents, and students. In classrooms where students engage in increased amounts of written work, teachers have to prepare more materials, correct more papers, and provide additional feedback to students concerning their additional work. This situation results in more work for the teacher. Home tutoring can be frustrating to parents when they are given no training in tutoring their children. Also, such assistance can be time consuming, and additional time is not available to families when both parents work or in single-parent families where the parent's time is in even more demand. Increased responding through additional seat work can also be a negative experience for the student because this type work is completed individually without the positive social learning interaction some researchers believe is a necessary part of any school curriculum (Vygotsky, 1978).

A final reason for low academic response rates posited by Hall et al. (1982) is that school policy and/or classrooms are not engineered ecologically to maximize responding for all students. Observations by Juniper Gardens consultants

confirm that ability grouping students results in less practice time for lower achieving students who are grouped together. At the beginning of the period, teachers often call upper level reading groups first, then middle level groups, and finally the lower level groups are called. When the lower level groups are called, usually little time is left in the period. In one particular class observed by Hall and his associates, the low level group participated in active reading only 1 day out of 6 and that involved a period of time of less than 5 minutes. Schools also were reported to discourage parents from tutoring their children in the same materials that were used in class. Teachers were concerned that parents may have created a negative experience if they pressed their children too hard or prolonged tutoring sessions. Also, some teachers were concerned that students would lose interest in material at school which they also used at home.

In light of these observations and the additional work of Delquadri and Greenwood (1981), Hall et al. (1982) suggested that a necessary condition for academic achievement is frequent interaction between teacher and/or antecedents and student responding. As a result of this research and additional research (Greenwood, Delquadri, & Hall, 1989; Stanley & Greenwood, 1983), a measurement system consisting of in-class observational coding was developed. Within the context of this model, learning is viewed as a result of

eco-behavioral interaction in the classroom. Environmental factors (e.g., time allocated for instruction, curriculum, tasks presented to students, and teacher behaviors) and the levels of active student responding (e.g., writing, reading aloud, and academic talk) are thought to be critical to student achievement (Delquadri et al., 1986). Greenwood, Dinwiddie, Terry, et al. (1984) empirically verified the relationships between different ecological and teacher arrangements, student response levels, and student achievement outcomes. These researchers compared the performance of students from two Title I schools during peer tutoring and traditional teacher-led instruction. Students exhibited better performance in spelling, arithmetic, and vocabulary during peer tutoring. Additionally, the students engaged themselves more frequently in academic tasks such as in writing, academic talk, reading aloud, and reading silently. These results were demonstrated across three different classrooms with three different subject matters regardless of treatment order.

Classwide peer-tutoring systems provide a means to increase levels of student responding by allowing peers to supervise their classmate's responses to academic tasks. A central issue for mainstream classrooms is how one teacher can monitor increased response levels for a classroom with 30 to 35 students. Classwide peer tutoring enables teachers to structure instruction so that constant monitoring can occur

in even large classrooms through the use of peer tutors. Students increase their academic behaviors from 20% to 70% during CWPT (Delquadri et al., 1986).

Research with Classwide Peer Tutoring

Classwide peer-tutoring research can be divided into two parts. The foundation of CWPT and much of its continuing development is centered at the Juniper Gardens Children's project in Kansas City, Kansas. Greenwood and his colleagues have been conducting research on the effects of CWPT since 1984 (Greenwood, Dinwiddie, Terry, et al., 1984). The research conducted at the Juniper Gardens Children's project has been primarily with low socioeconomic status, inner-city children. Many of the studies at the Juniper Gardens project involved children who qualify for Chapter One programs. A second body of CWPT research involves students with disabilities. Although the two bodies of research do not involve identical populations, these children share many of the same demographic characteristics and educational difficulties. For this reason and also because the research of Greenwood and his colleagues form a large base of the CWPT literature, both bodies of research are included in the following discussion.

The Juniper Gardens Children's Project

Greenwood, Dinwiddie, Terry, et al. (1984) investigated the effects of CWPT on the spelling, arithmetic, and vocabulary achievement of 128 students from two Title 1

schools. Each student in the study was at least 5 months below grade level across all subject areas. The researchers used a counterbalanced reversal design with three phases across classes: ABA, BAB, and ABA. Two interventions were compared. One condition was classwide peer tutoring while the other condition was the use of ordinary teacher procedures. Students were divided into a "low"-functioning group which represented the four lowest achieving students in each class and an "other" group which included the rest of the students. The results indicated that low level groups as well as the other group performed best with CWPT in all three academic areas. During tutoring, the low group performed as well as the other group, but this was not the case for matched/similar students during the teacher procedures condition. These results were demonstrated across three different classrooms and within different subject areas. Additionally, observations confirmed that during CWPT students engaged more frequently in writing tasks, academic talk, reading aloud, and reading silently.

In a longitudinal study, Greenwood, Dinwiddie, Bailey, et al. (1987) examined the effects of CWPT on the spelling achievement of 211 inner-city students from grade 1 through grade 2. A total of 99 students completed the study. The authors described this design as a longitudinal field replication design with single-subject design features (i.e., baseline, reversal, pretest probes). When comparing

baseline, intervention, and reversal conditions across the 2-year period, the researchers reported that students scored significantly higher during CWPT instruction compared to ordinary teacher instruction procedures (baseline) $F(2, 194) = 37.1, p < .001$. Survey results indicated that teachers were generally satisfied with the program, where teacher rating means over six general satisfaction items ranged from 3.3 to 4.6 on a 5-point scale. Most items on the student survey received a rating of 2.4 or better on a 3-point scale, reflecting general satisfaction by the students. One exception was students' reaction to the error-correction procedure used by tutors, which received a mean of 2.0 for each year. Student satisfaction was less positive than teacher satisfaction, but student satisfaction was still generally positive in nature.

Greenwood et al. (1989) also conducted a longitudinal study, measuring the effects of CWPT on the reading, math, and language arts achievement of 416 students from six Chapter 1 schools and three non-Chapter 1 schools. The researchers followed the students from first grade through fourth grade. Ninety-four teachers participated in the study. The study compared the results of an experimental group which received CWPT and a control group which received traditional teacher designed instruction. A pretest/posttest design was incorporated using the Metropolitan Achievement Test-Basic Battery as the measurement instrument. The

experimental group (CWPT) scored significantly higher in each academic domain compared to the control group (teacher-designed instruction). A significant ANCOVA effect was noted for reading, $F(2, 175) = 16.43$, $p = .0001$, for mathematics, $F(2, 175) = 4.17$, $p = .0170$, and for language, $F(2, 175) = 11.18$, $p = .0001$.

Greenwood (1991a) used the same sample to measure the amount of engaged academic time of students under CWPT compared to students under teacher-designed instruction. The low SES students under CWPT instruction showed increased levels of engaged academic time compared to the teacher instruction control group from the onset of first grade and consistently over time.

In another longitudinal study, Greenwood (1991b) investigated the spelling, math, and reading achievement of 211 students from four Chapter 1 schools as they progressed from first grade to fourth grade. Both the experimental group and the control group consisted of students at risk for academic delays and school failure, and students who were of low socio-economic backgrounds. The experimental group was given CWPT instruction throughout the 4-year period while the control group received conventional instructional practices. Students in the experimental group made significantly greater gains on the Metropolitan Achievement Test than did the control group. The CWPT group exceeded the control group from 9 to 13 percentiles across subtests. In terms of effect

sizes, experimental group gains over the control group ranged from 0.37 standard deviations in math, to 0.57 standard deviations in reading, to 0.60 standard deviations in language. Each effect size surpasses the 0.25 minimum criterion cited by the authors for discriminating between effective and noneffective practices. Furthermore, the scores of the experimental group approached the normative levels on each subtest of a comparison group of not-at-risk students from high socioeconomic status households. Finally, fewer students from the experimental group were placed into special education 2 years later.

Finally, Greenwood, Terry, Arreaga-Mayer, and Finney (1992) assessed the spelling achievement of 98 low SES inner-city students in grades 2, 4, and 5. This study was described as a nonexperimental multimeasure clinical replication design. This type of design replicates a well-defined treatment procedure with a large number of participants for the purpose of establishing the generalizability of its effectiveness in an applied setting (Barlow, Hayes, & Nelson, 1984). Since CWPT is a well-defined and well-researched procedure, it is an appropriate object of a clinical replication design. Students completed weekly pretests and posttests during CWPT implementation for one school year. Results revealed that these students attained a mean gain of 39.7% from pretest to posttest over the year's period of time. Additionally, the investigators

reported that variations in students' spelling outcomes were associated with differences in teacher implementation. Implementation factors which were found to be associated with students' outcomes include reductions in strength of treatment (i.e., CWPT opportunity and student participation), low program fidelity (i.e., unchallenging spelling words at pretest), and low point earnings during tutoring. The limitation of this study is that it is descriptive in nature rather than experimental. A control group was not used to determine whether pre-/posttest gains were indeed the result of CWPT. The findings of this study await validation by future experimental studies of CWPT implementation.

In summary, evidence has been presented by the Juniper Gardens Children's Project that demonstrates the effectiveness of CWPT with economically disadvantaged students. These students have shown improvement in basic academic skills with CWPT. Importantly, the amount of academically engaged time for these students also has been demonstrated to increase with CWPT. Limitations of this research include the characteristic that only elementary age students have been studied and also that the academic focus has been only on basic academic skills.

CWPT and Students with Disabilities

The results of the previous studies by Greenwood and his colleagues at the Juniper Gardens Children's Project strongly support the efficacy of CWPT as an instructional strategy

with low-achieving students from low SES backgrounds. The following studies describe the efficacy of CWPT and students with disabilities.

Special education settings. Three studies examined the academic achievement effects of CWPT for students with disabilities within special education classrooms. Harper, Mallette, and Moore (1991) investigated the spelling achievement of 12 primary grade students in a self-contained class for students with mild mental retardation. An AB (baseline, intervention) design was used to determine achievement effects. Weekly test scores taken from the students' weekly vocabulary units were the dependent measure. Baseline lasted 3 weeks while CWPT intervention occurred for 14 weeks. Mean class test performance improved from an average of 36.6% during baseline to an average of 96.6% during intervention. Students' point totals continued to increase throughout the intervention, indicating that students were becoming more proficient and more successful with CWPT. Additional evidence of student success using CWPT is that the number of student opportunities to respond also increased steadily throughout the study. Social validity data as measured by the Peer Tutoring Evaluation Inventory indicate positive attitudes of students toward CWPT.

Mallette et al. (1991) evaluated the achievement effects of CWPT with nine elementary age students in a self-contained class for students with mild mental retardation. Spelling

was also the target domain. One student without disabilities served as tutor for each student. Basically, these researchers examined student scores on weekly tests. Separate scores were determined for five or six words practiced the week of the test and those words from previous weeks. During a 12-week period of time, students averaged 95.34% correct for new words. In terms of retention of previous words, students averaged 73.89% correct from the previous week, 85.1% for words from the previous 2 weeks, and 79.17% correct for words from all previous weeks. A posttest with 25 words randomly selected from the total word list resulted in a class average of 87.78%. Student opportunities to respond averaged between 2.60 to 7.29 times (writing the word) per word. Survey data indicate that student attitudes toward the intervention were positive. Limitations of the study include a small student sample which weakens generalizability, and no control group was used which makes it difficult to determine whether academic gains were truly the result of the CWPT intervention.

The third CWPT study involving students with disabilities in a strictly special education setting is Dupaul and Henningson (1993). These researchers examined the math achievement of a 7-year-old boy identified with Attention Deficit Hyperactivity Disorder (ADHD) during CWPT. This study was a single subject ABAB reversal design. Baseline consisted of math instruction via "typical"

classroom routine. The researchers reported increases in on-task behavior and reduction in motor restlessness during CWPT. Eighty-nine percent of the students' behavior was on task. Return to baseline resulted in a decrease in on-task behavior (average 70%). Upon resumption of CWPT, on-task behavior again increased to a 90% level. The student's performance on curriculum-based math probes indicated that CWPT resulted in improved math performance. Math scores for 25 two- and three-digit addition and subtraction tests increased somewhat during the first intervention with CWPT (from an average of 5.0 correct during baseline to 8.6 correct during CWPT). Return to baseline resulted in an average score of 7.0 correct. Resumption of CWPT resulted in a more substantial increase in correct responses to an average score of 13.3 correct.

In examining these three studies, it is apparent that CWPT helped students with disabilities improve their academic performance. However, these investigations only include two subject areas, spelling and math. Moreover, each study included only a small sample which limits the generalization of the results. Also, the results of these studies do not directly apply to mainstream classrooms. The importance of these studies is that they provide support that CWPT has been used effectively with several disabled student populations.

Mainstream elementary classrooms. Maheady and Harper (1987) examined the spelling achievement of 70 third- and fourth-grade students during CWPT. Sixty percent of these students received supplemental services in either remedial or special education programs (34 Chapter 1 students and 7 students with learning disabilities). The researchers employed an ABAB multiple baseline design across four classes. Classwide peer tutoring implementation resulted in immediate and systematic increases in weekly test performance. Group mean scores on weekly tests increased from 78.58% during baseline to 93.39% during CWPT. Treatment effects were significant at the $p < .001$ level, using the t -test. As in Maheady et al. (1987), the percentage of "A" grades increased dramatically during CWPT, and the number of failing grades decreased substantially. The percentage of "A" grades increased from an average of 50% to an average of 87% during CWPT intervention. Failing grades decreased 14 percentage points during CWPT, from an average of approximately 17% during baseline to an average of approximately 3% during CWPT intervention. Student and teacher satisfaction with using CWPT was positive based on survey and interview data.

Maheady, Harper, Mallette, and Winstanely (1991) evaluated the effects of CWPT on the spelling achievement of 198 fourth- and fifth-grade students from one low SES school (50% low SES students) and one school with students from

predominately nonminority, mid-SES backgrounds. Included in this sample were 18 students with learning disabilities. The study was conducted in eight general education classes and featured an ABAB design. Immediate increases in student spelling scores occurred upon implementation of CWPT. For six classes, the average increase was approximately 20 points. With the addition of the two remaining classes, the average increase in scores was only 10.37%. Mean student scores across the four phases of instruction were as follows: A1--81.89%, B1--91.7%, A2--79.95%, B2--90.92%. Overall teacher satisfaction was positive although their opinion about the use of points and the public display of student points was not favorable. The students generally reported that their experiences with CWPT were positive in nature. A limitation of the study was that participants were volunteers. This condition could bias the data because some participants may have volunteered for the study with the belief that CWPT was going to help them. Also, spelling was chosen as the target domain, and the authors reported that spelling is one of the easiest domains in which to use CWPT. Material development demands are minimal and instructional procedures are specific and easily followed. Maintaining proper implementation procedures is less difficult in such a domain, and the researchers were uncertain whether similar results would occur in more time intensive subject areas.

In summary, these two studies each demonstrated the effectiveness of CWPT in producing positive spelling achievement effects with elementary age students in mainstream classrooms. Additional research which replicates these findings is needed as well as additional investigations into CWPT's effects with other content areas within this student population. Another helpful addition to this research would be to examine separately the scores of students with disabilities and compare these results to students without disabilities. This procedure would help researchers verify whether CWPT is similarly effective for both students with disabilities as well as students without disabilities or whether CWPT has different effects between the groups. Such an examination was not completed in the above studies.

Mainstream secondary classroom. Maheady et al. (1988) used a multiple baseline design to assess the social studies achievement of 50 tenth-grade students. Included within this sample were 14 students with mild disabilities (learning disabilities or behavior disorders). An ABAB reversal design was instituted in two of the three classrooms. Weekly test scores in social studies were the dependent measure. The teachers and students in the study were involved in Project PASS, a school program in which general education content area teachers accepted three to six mildly disabled students in classes with lower student numbers (15 to 20). Therefore,

this study was conducted in mainstream classrooms during regularly scheduled instructional periods.

Immediate and systematic increases in the test performance of both students with mild disabilities as well as students without disabilities were present with CWPT. Test scores for the entire sample increased an average of 21.66 percentage points from baseline to CWPT intervention. The students with mild disabilities are reported to have similar results although specific scores are not given. For the two classes under the withdrawal condition, the return to baseline resulted in an average decrease of 21 percentage points. Classwide peer tutoring was reintroduced after only 1 week because of ethical concerns about denying students a more effective instructional method. After resumption of CWPT, test scores increased dramatically and exceeded baseline scores in all instances. However, specific scores for this phase are not provided. The percentage of "A" grades are reported to have increased and "E" grades to have decreased during CWPT, but again complete data are not reported for all samples and all phases. Aspects of this study in which data are fully reported convincingly demonstrate the effectiveness of CWPT, but the lack of data for other aspects of the study reduces its meaningfulness because a full report of the data is necessary to determine whether the effects are consistent across groups and between

dependent measures. The authors failed to make a convincing case without reporting all the data.

Maheady, Sacca, and Harper (1988) also investigated the effects of CWPT on the social studies achievement of high school age students. The sample consisted of students in grades 9-12 in a resource room for students with mild disabilities (LD, BD, & EMR). An ABAB withdrawal design across two settings was instituted over an 18-week period. Classwide peer tutoring resulted in improved weekly test scores, and substantially more students earned grades over 90% compared to baseline. Classroom 1 showed a dramatic increase in weekly test scores during CWPT with an average increase of 20 points on weekly tests. One-third of the class earned "A" grades per week. Upon a return to baseline (traditional teacher classroom routine), weekly test scores decreased an average of 22.40 points. Failure rates increased to nearly one-half of the class. Return to CWPT resulted in average gains of 17.04 points on weekly test scores.

Students in classroom 2 showed more modest gains in average weekly test scores than classroom 1. Weekly test scores increased an average of 8.23 points over baseline (from 73.46% to 81.69%). Upon return to baseline, weekly test scores decreased 21.97 points to an average of 58.51%. Additionally, one-half of the class received failing grades while only two students received grades above 90%. Upon

reintroduction of CWPT, weekly test scores increased 29.33 percentage points, and 70% of the students received "A" grades. No failing grades were made during this phase of intervention.

The majority of students reported that they enjoyed CWPT according to results of a 17-item survey. Teachers also reported satisfaction with CWPT and believed that it helped their students improve performance.

The preceding two studies represent the literature found as it relates to the effects of CWPT and secondary age students in mainstream classes. Only one subject area (social studies) has been investigated with this population, and the authors in one study (Maheady et al., 1988) failed to report data fully. Although social studies is certainly an important subject area in the curriculum, additional research with secondary students is necessary, and this research should extend to additional content areas. Failure to report data to support conclusions reduces the strength of one study. A methodological flaw in each of these studies is that they report to use ABAB withdrawal designs, but in each study, the withdrawal phase lasted for only 1 to 2 weeks which represented only 1 to 2 data points for each study. Although Maheady et al. (1988) reported that the withdrawal procedure was discontinued because of ethical concerns and student complaints, additional data would be necessary to illustrate clearly withdrawal of CWPT treatment effects.

Another problem with these studies is that important data are not reported. Most obvious is that specific data regarding the number of "A" grades and the number of failing grades are not reported. In some cases statements are made about the increase or decrease in such grades during CWPT, but specific numbers are sometimes not present.

Interestingly, in some cases the Number of "A's" were reported for one sample during one treatment phase, yet the number of "A's" for the same sample in the next phase of treatment was not reported.

Research with CWPT and Higher Order Cognitive Skills

Almost exclusively, basic academic skills have been the focus of CWPT research. The only exception to this trend found in the literature is the work being done at Vanderbilt University with Peabody Classwide Peer Tutoring. Mathes, Fuchs, Fuchs, Henley, and Sanders (1994) described their work using CWPT to improve students' reading comprehension skills. These researchers incorporated two procedures which require students to use synthesis and interpretation to practice and improve their reading comprehension. One of these procedures, paragraph shrinking, requires students to develop comprehension through a main idea and idea identification strategy. During paragraph shrinking, the reader reads orally one paragraph at a time, stopping after each to identify its main idea. The reader must state the main idea in 10 words or less so that they better understand the

concept of summarization. The tutor is responsible for determining whether the answers are correct. The authors reported that many students have difficulty summarizing the main idea in succinct fashion, but with practice they become proficient at it.

A second higher order cognitive strategy to improve reading comprehension described by Mathes et al. (1994) is prediction relay. This activity extends paragraph shrinking to larger chunks of connected text which requires students to think ahead. Prediction relay requires five steps. The reader makes a prediction about what will be learned on half a page of text, reads the half page aloud, confirms or disconfirms the prediction, summarizes the half page in 10 words or less, and makes a new prediction about the next half page. It is the readers' job to determine whether the reader makes a reasonable prediction, accurately reads the half page, accurately checks the prediction, and correctly summarizes the important information.

Although no actual data are presented (this document is a descriptive report on the Peabody CWPT procedures the authors have developed), the authors concluded that Peabody CWPT promotes markedly better reading achievement than conventional instruction in a wide range of learner types, including students with learning disabilities, low-achieving students, and average-achieving students. Also, this work

demonstrates the use of CWPT in higher order cognitive skill instruction.

A second study which adds some insight into the positive effects peer-mediated instruction can have on learning higher order cognitive skills is Harper, Mallette, Maheady, and Brennan (1993). Although these researchers did not use CWPT in this investigation, they used a hybrid form of CWPT called Classwide Student Tutoring Teams (CSTT). Classwide Student Tutoring Teams are a form of peer-mediated instruction that allow students to master previously introduced subject matter material. Classwide Student Tutoring Teams has six basic elements: (a) Students are assigned to small heterogeneous groups to practice previously introduced instructional material; (b) students take turns acting as teacher, and all students have the opportunity to teach and to be taught; (c) while in the tutor role, students follow carefully prescribed procedures for teaching, evaluating peer responses, and providing feedback; (d) students earn points for correct or corrected responses; (e) points are publicly posted; and (f) teams compete against each other to earn the most points in any week. The primary difference between CSTT and CWPT is that CSTT groups students into heterogeneous teams of three to five students. In CWPT, students are grouped into tutoring pairs, and an equal number of tutoring pairs make up two teams in each classroom. A second difference is that students in CSTT are always grouped

according to their rank in academic content performance. Each team consists of one high-, one average-, and one low-performing student. In CWPT, students can be paired in a variety of ways (by random assignment, based on academic skill level, because of complementing behavior characteristics).

Subjects were 52 second-grade students in two mainstream classes. Each class contained three to four students with mild disabilities. Target academic content was addition and subtraction word problems. Direct instruction and strategy instruction were used to assist students in solving word problems. Direct instruction consisted of scripted lessons for teachers and frequent interaction between teacher and students. Arrow strategy instruction was provided to guide students in solving addition and subtraction word problems. Arrow strategy instruction consists of students drawing an arrow and then placing the "small" numbers on the top stem of the arrow and the "big" number at the end of the arrow. For example, the problem $6 + 9 = 15$ is written so that the 6 and the 9 are placed on the top side of the stem of the arrow and the 15 is placed at the end of the arrow. With this configuration, the student is able to visualize the four different facts derived from this family: addition-- $6 + 9 = 15$, $9 + 6 = 15$; subtraction-- $15 - 9 = 6$; $15 - 6 = 9$.

A multiple baseline design was implemented across four word problem types: addition problems with key words,

subtraction problems with key words, "big number" problems, and classification problems. After direct instruction and arrow strategy instruction, the students practiced the skills taught using CSTT. Biweekly probes were administered and scores from these probes served as the primary source of data. Results from this exploratory investigation are mixed. Overall improvement in math word problem solving for the classes was evident. Improvements in the percentage of problems correctly solved averaged 30.9% in Classroom A (pretest--61.9%, posttest--92.8%) and 26.8% in Classroom B (pretest--60.3%, posttest--87.1%) over a 10-week period. Improvement in the solution acquisition performance of only students with disabilities between pretest and posttest was similar. Students with disabilities in Classroom A improved their scores by 27% (pretest--53.0%, posttest--80%) while students with disabilities in Classroom B improved their scores by 28.4% (pretest--58.3%, posttest--86.7%)..

Strategy acquisition (the degree to which students used the correct strategies to solve word problems) for the students overall was quite different between classes. Overall differences between pretests and acquisition measures averaged only 14.4% in classroom A (pretest--57.6%, posttest--72.0%) but averaged 50.2 % in Classroom B (pretest--32.6%, posttest--82.8%). Students with disabilities did not perform as well as the classes overall. Average improvement for Classroom A was 7.9% (pretest--39.0%,

posttest--46.9%), and average improvement for Classroom B was 17.7% (pretest--46.9%, posttest--64.6%). Additionally, the acquisition scores of the students with disabilities were not satisfactory. The average acquisition score for students with disabilities in Classroom A was 46.7% while the comparable average score for students with disabilities in Classroom B was 64.4%. These scores would result in failing or near failing grades for these students.

Following the completion of the investigation, students were administered a 25-item posttest consisting of a random sample of all problems practiced during the 10-week intervention. Separate scores were obtained for answer accuracy and accurate use of the appropriate strategy. In classroom A, students averaged 83.3% for answer accuracy. The correct strategy was used on an average of 52.9% of the problems. Results in Classroom B were 83.5% and 79.5%, respectively. For students with disabilities, the average posttest score on problem solving was 78% in Classroom A and 78.7% correct in Classroom B. For strategy use, these students averaged 38% correct and 85.3% correct, respectively.

These results reflect the overall difficulty students have in learning correct strategy use for word problem solving. Additionally, students with disabilities did not perform nearly as well as the overall performance of their classes in either solution accuracy or in strategy use

accuracy. The authors noted that the inaccuracy of strategy use could be due to carelessness. Whether this supposition is correct or incorrect, the considerable amount of variation between classes and between students with disabilities and students without disabilities is not readily explained.

Although the results of this study are mixed, this study represents an initial attempt to measure the effectiveness of using peer mediated instruction to assist students in learning math problem solving. A problem with the design of this study is that the researchers did not compare the effectiveness of CSTT with traditional individual worksheet practice, a common method of academic skill practice. It cannot be determined from this study whether individual student practice would be more effective than the peer-mediated instruction of CSTT. Such a comparison is important if alternative instructional methods are to be proven effective over traditional types of instruction.

Summary of Classwide Peer-Tutoring Research

The classwide peer-tutoring research can be summarized in two areas. First, research reviewed from the Juniper Gardens Children's Project is summarized. Second, the research reviewed regarding students with disabilities is summarized.

The Juniper Gardens Children's Project

The research base formed by the many researchers involved with this project demonstrate the effectiveness of

CWPT in improving the academic performance of economically disadvantaged children. Positive achievement effects have been demonstrated in several content areas (spelling, math, reading, and language skills). Additionally, CWPT has been demonstrated to increase engaged academic time of students in this population (Greenwood, 1991b; Greenwood, Dinwiddie, Terry, et al., 1984). However, there are several limitations to this research. First, all the research has taken place with elementary age children. Investigations with secondary age students have not been undertaken within this research base. Second, although low-achieving students have been the focus of this research, students with disabilities have not been identified. Third, the academic focus of these researchers has been on basic skills (spelling words, basal reading, basic math facts and calculations). Measurement of CWPT effects with higher order cognitive skills has not been addressed. Fourth, focus on social/emotional variables has been minimal.

Students with Disabilities

There are several areas of concern regarding the effects of classwide peer tutoring on students with disabilities. These areas include academic achievement, type of setting, and social behavior. In terms of academic achievement, CWPT has consistently resulted in improvement in academic skills for students with disabilities in regular classroom settings as well as students in separate special education settings.

Positive achievement effects have been found in several content areas--math, spelling, and social studies. Although these results are encouraging, it is important to note that the type of academic skills that have been studied are almost exclusively basic and fundamental skills. Little research has been directed to investigating whether or not CWPT can be effective instruction for higher order cognitive skills. The lone exception to this trend is the work described by Mathes et al. (1994). Investigating the effects of CWPT with higher order cognitive skills is imperative if the promising outlook for CWPT as an effective instructional strategy can be extended to secondary education. Since much of the academic content in secondary schools requires advanced thinking skills, research concerning the effectiveness of CWPT with these types of skills is of paramount importance.

A second concern related to CWPT and students with disabilities is whether CWPT is an effective instructional strategy for diverse mainstream classrooms. With the current emphasis on inclusive education, it is important that effective instructional strategies be examined and refined so that appropriate education can be delivered in classrooms which contain students with and without disabilities and students who are and are not at risk of academic failure. These instructional strategies must be effective for all students. To develop such strategies, research must focus on integrated or mainstream classes. In examining the

literature, several research studies have attempted to do this (Maheady & Harper, 1987; Maheady, Harper, Mallette, and Winstanely, 1991; Maheady et al., 1988), but much more needs to be learned. Replication of CWPT academic achievement effects in integrated or mainstream classes needs to occur as well as an additional focus on whether these effects are more or less pronounced for students with disabilities. Only one study (Maheady et al., 1988) separately reported data for students with and without disabilities. The three studies which assessed CWPT achievement in strictly special education classes (Dupaul & Henningson 1993; Harper et al., 1991; Mallette et al., 1991) demonstrated positive results for students within that setting, but the degree to which these positive results generalize to mainstream settings has not been adequately researched.

A third important variable which needs additional research concentration is the social effects of CWPT. Principally, it must be determined how influential CWPT can be in producing positive social gains for students with disabilities. While several studies report social behavior effects, these data do not clearly identify the range of social/emotional functioning affected by CWPT. Some general peer-tutoring studies report changes in attitudes of students without disabilities toward students with disabilities (Cooke et al., 1985-86; Scruggs et al., 1985), but the extension of peer-tutoring effects to more global social/emotional domains

such as self-esteem has not been reliably substantiated (Cook et al., 1985-86; Osguthorpe & Scruggs, 1986; Scruggs & Richter, 1985). Examination of social/emotional variables with CWPT and students with disabilities is virtually nonexistent. Some researchers have touched on this issue through the use of peer-tutoring surveys and inventories in measuring participant satisfaction (Maheady & Harper, 1987; Maheady, Harper, Mallette, & Winstanely, 1991; Maheady et al., 1988), but any concentrated study on social variables as they relate to CWPT is not evident in the literature.

This study addresses several areas of concern regarding CWPT research. First, this study examines the effects of CWPT in teaching higher order cognitive skills, in this case algebra problem solving. Second, this study examines CWPT effects within a mainstream setting. Moreover, the middle grades (6-8) are the school setting, a setting which has yet to be explored in the literature.

Higher Order Thinking--Math Problem Solving and Students with Disabilities

Since the focus of this study is to determine whether CWPT can be an effective instructional strategy for higher order cognitive skills, it is important to discuss the nature of the academic skills that were taught in this study. Mathematical problem solving, specifically division equations and algebra word problems, is the academic skill area which was taught. Solving such problems requires higher order thinking. Higher order thinking is defined as thinking which

comprises understanding, reasoning, and problem solving (Grossen, 1992). Math problem solving necessitates the use of all three of these principal qualities of higher order thinking. Based on a review of the math literature, Montague and Applegate (1993) concluded that mathematical problem solving requires coordinated application of a complex system of cognitive and metacognitive processes and strategies. Mayer (1993) discussed four basic cognitive processes required to solve word problems: *translating* each sentence into an internal mental representation, *integrating* the information into a coherent mental model of the situation, *planning* the steps in a solution, and *executing* the plan by carrying out needed operations. Math problem solving as described by these researchers reflects the need for understanding and reasoning and certainly represents the characteristics of higher order thinking. To solve such problems, the student must understand the meanings of the symbols, numbers, and words provided. Additionally, the student must generate some reasoning format, such as a strategy or formula, to solve the problem. Through understanding the symbols and numbers, and comprehending the words, the student is able to apply a rational process or strategy for problem solving.

Since math problem solving requires higher order thinking, it is an appropriate academic skill area for this study. Therefore, it is necessary to examine current

literature related to math problem solving to determine effective instructional practices for teaching math problem solving. Specifically, this discussion presents math problem-solving literature as it relates to students with disabilities.

Many students with disabilities have difficulty mastering math skills. Carpenter (1985) surveyed 110 learning disabilities resource room teachers and found that one-third of their instructional time was spent teaching math. With increasing frequency, deficits in mathematical functioning have been recognized as a serious problem for students with learning disabilities (Hutchinson, 1993). Learning problems in math traditionally have not been focused upon nearly as much as other academic areas (Mercer, 1992).

More recently, this trend has been changing. The work of several researchers has resulted in an increasing research emphasis on instructional variables important for students who have difficulty with math. Cawley (1985) examined the math literature concerning students with learning disabilities and concluded that the focus of this literature has been primarily on arithmetic computations. Moreover, Cawley (1985) determined that within this computational emphasis, practice of mathematics skills is limited to rote drill and practice with little emphasis placed on meaning or the use of arithmetic tasks to facilitate cognition. Cawley (1985) suggested that math instruction which includes an

emphasis on cognition--reasoning, problem solving, thinking, discriminating--is of great need.

Several other math authorities contend that students with disabilities have difficulty in math because they do not use cognitive strategies in computation or problem solving. Torgesen and Kail (1980) reported that children with learning disabilities fail to use organized strategies that facilitate memorization and recall. Several researchers from the University of Kansas have extensively researched the effects of cognitive strategy instruction and have been successful in assisting students with learning disabilities to learn math skills (Deshler, Schumaker, & Lenz, 1984; Hallahan, 1980). Montague and Bos (1986) used an eight-step cognitive strategy for assisting students with learning disabilities to solve verbal math problems. The researchers reported that maintenance and generalization of the cognitive strategy occurred.

Problem solving is a mathematics skill which is of particular importance for students with learning difficulties. A major emphasis is placed on problem solving in high school mathematics curricula (Dossey, Mullis, Lindquist, & Chambers, 1988). Expectations for greater competence in math are increasing for students with learning difficulties. Some states, like North Carolina, have begun to require all high school students to pass algebra before they receive a diploma. After reviewing the literature

regarding students with learning disabilities and their problem-solving capabilities, Hutchinson (1993) reported that these students frequently lack essential problem-solving knowledge and exhibit deficits in effectively using specific mathematical strategies. Hutchinson (1993) concluded that problem solving is an important topic for research, given (a) the importance of problem solving in high school mathematics courses like algebra, (b) the difficulty students with learning disabilities experience in mathematics problem solving, and (c) the time expended to remediate these problems.

Mayer (1993) suggested that the next logical step toward effective mathematics instruction for students with disabilities is to develop instructional programs that explicitly teach students to use cognitive and metacognitive strategies to solve mathematics problems. Zawaiza and Gerber (1993) concurred with this position by stating that an increase in metacognitive abilities is necessary for students with learning disabilities if they are to become successful in problem solving. Montague and Applegate (1993) proposed that the strategies which students with learning disabilities use are qualitatively different than those used by students without learning disabilities. These researchers examined the "think-aloud" protocols of students with learning disabilities taken while these students were solving different types of word problems and report that these

students lack specific cognitive strategies and use fewer metacognitive processes when compared to those strategies used by gifted students.

Considering the literature discussed in relation to problem solving and students with disabilities, it is apparent that these students are in need of effective problem-solving instruction. Additionally, after examination of this literature, several types of instruction seem to be promising approaches to problem-solving instruction. Among these types of instruction are explicit and direct instruction (Mayer, 1993) and metacognitive or strategy instruction (Deshler et al., 1984; Montague & Applegate, 1993; Torgesen and Kail, 1980; Zawaiza & Gerber, 1993).

Summary

Peer tutoring has been used as an instructional strategy throughout modern history. The effects of peer tutoring and students with disabilities have been explored only recently. Peer tutoring has developed from a strong theoretical base including learning theory, principles of effective instruction, social learning theory, and cooperative learning. The literature consistently documents positive academic improvement for students with disabilities when using peer tutoring.

Classwide peer tutoring is a relatively new type of peer-tutoring instruction that has been shown to be effective for students with disabilities as well as for those students

who are at risk of academic failure yet have not been identified as having a disability. Primary instructional benefits of classwide peer tutoring are increasing students' opportunities to respond academically and frequent and immediate feedback on performance.

Explicit training and systematic implementation are necessary for students to achieve these benefits. Research findings suggest that classwide peer tutoring has been quite successful in helping students improve their abilities to perform basic academic skills such as solving math facts, word recognition, and spelling. Whether classwide peer tutoring can be effective when teaching higher order cognitive skills has not been substantiated.

Since higher order cognitive skills are increasingly used as a students enter middle school and throughout high school, the importance of instructional practices which effectively teach students these skills is of great importance. Moreover, the recent trend toward including more students who have learning difficulties in the regular classroom will require innovative instructional strategies to accomplish the goal of successful instruction for all students. Because classwide peer tutoring uses students within the same classroom who may have diverse skills, it is a potentially important instructional strategy for mainstream classes.

Considering these factors it is an important goal to determine the effectiveness of classwide peer tutoring for teaching higher order thinking skills to middle school age students with a variety of learning characteristics. Further research in this area is needed and will provide educators with additional knowledge of how to integrate students with learning difficulties into the educational mainstream.

CHAPTER III METHOD

The purpose of this study is to determine whether middle school students in mainstream classes are able to learn higher order cognitive skills (i.e., algebra problem solving) using classwide peer tutoring (CWPT). This chapter outlines the methods and procedures used in this study. The first section lists the hypotheses. The next section describes the subjects, the sampling procedures, and the measures. The last two sections describe the procedures used as well as the treatment of the data.

Hypotheses

The study examined the effects of classwide peer tutoring (CWPT) on algebra problem solving with middle school students. The general question of the study was as follows: Does CWPT help students to solve algebra word problems with greater accuracy than students who use traditional independent practice? The following null hypotheses are posited for testing at the .05 level of confidence.

H₁: There will be no statistically significant difference in performance on algebra problem solving (from pretest to posttest) between treatment groups (CWPT & independent practice).

H₂: There will be no statistically significant difference in performance on algebra problem solving (from posttest to maintenance test) between treatment groups (CWPT & independent practice).

H₃: There will be no statistically significant difference in performance on algebra problem solving (from pretest to posttest) between the at-risk group and the not-at-risk group.

H₄: There will be no statistically significant difference in performance on algebra problem solving (from posttest to maintenance test) between the at-risk group and the not-at-risk group.

H₅: There will be no statistically significant difference in performance on algebra problem solving (from pretest to posttest) among four groups (CWPT/at risk, CWPT/not at risk, Independent Practice/at risk, Independent Practice/not at risk) as determined by the interaction between treatment group and at-risk classification.

H₆: There will be no statistically significant difference in retention (from posttest to maintenance test) of algebra problem solving among the four groups (CWPT/at risk, CWPT/not at risk, Independent Practice/at risk, Independent Practice/not at risk) as determined by the interaction between treatment group and at-risk classification.

Subjects

Subjects included 262 eighth grade students in 14 different general mathematics classes in three middle schools in Marion and Alachua counties, Florida. The age of students ranged from 12 years to 15 years, with 2% of the sample age 12, 74% of the sample age 13, 22% of the sample age 14, and 2% of the sample age 15. One hundred twenty-nine students (49%) were male, and 133 (51%) students were female. Seventy-two percent of the students were white; 21% were black; and 7% were Hispanic. The mean of student general math standard scores on the California Test of Basic Skills (CTBS) was 5.20 (range: 1.00-9.00). Eighth-grade students were selected as subjects because this is the grade level in which general math students begin exposure to basic algebra skills. There were four eighth-grade math teachers who participated in the study. Three teachers were female and one teacher was male. All teachers had over 10 years of teaching experience. All teachers were certified to teach math in the Florida public school system. Teachers did not have previous training in the algebra curriculum or in CWPT. Subjects included 99 students (38%) identified as at risk of math failure (scored a stanine of "3" or less on the general math section of the California Test of Basic Skills or the California Achievement Test and/or had a current grade of "D" or lower in their math class) and 163 students identified as not at risk of math failure (scored above a stanine of "3" on

the general math section of the California Test of Basic Skills or the California Achievement Test and had a current grade of "C" or better in their math class).

Research Instrumentation

The research instruments used in this study included a pretest, a posttest, and a maintenance test measuring algebra equation and word problem-solving ability. Fidelity of treatment was measured by a 38-item checklist for CWPT implementation procedures. Social validity was measured by a 19-item Likert scale evaluation inventory which assesses students' perceptions about CWPT. An informal survey format was used to assess teacher reactions to using CWPT.

Solving Division Equations Pretest, Posttest, and Maintenance Test

The pretest and posttest measures (see Appendices A and B) come directly from those in Solving Division Equations: An Algebra Program for Students with Learning Problems (Mercer, Enright, & Tharin, 1994). The maintenance test (see Appendix C) was developed by the researcher and included items which assessed the same skills as those assessed in the pretest and maintenance test. Care was used to ensure that the same skills were assessed and that the specific skills assessed were in the same proportion as those on the pretest and posttest. Each test measures skills needed to solve division equations and algebra word problems. The tests have 20 items which progressively introduce problems from "solving

for one variable" in a linear equation to solving one variable division equations in word problem form.

CWPT Implementation Checklist

This is a two-category, 38-item checklist of major components of CWPT developed by Carta, Greenwood, Dinwiddie, Kohler, and Delquadri (1987) which was modified to accommodate use with the algebra curriculum (see Appendix D). Items on the checklist were scored as either present or absent. The categories included Teacher Implementation (organization and set-up, general implementation, and monitoring and motivation) with 12 items and Student Implementation (general procedures, coaching behaviors, and player behaviors) with 26 items. Five raters made observations using the checklist during the intervention. They included this investigator, a special education doctoral student, two proteach special education students, and a graduate of the University of Florida who minored in education. Appendix D presents an example of the checklist used for observation. Each CWPT group was observed at least two times. Interrater reliability was monitored by pairing two observers for at least one observation for each CWPT group.

Peer Tutoring Evaluation Inventory

All students responded to a 19-item social validity questionnaire assessing satisfaction with CWPT procedures (see Appendix E). Items were orally read by the teacher, and

students marked their responses according to a 3-point Likert-type scale. This questionnaire is a slightly modified version of one that has been used in several CWPT studies (Harper et al., 1993; Maheady & Harper, 1987; Mallette et al., 1991). Modifications were made which adapted the questionnaire for use with algebra problem solving.

CWPT Teacher Informal Interview

Teachers were interviewed by the researcher to assess their perceptions of using CWPT. General questions about using CWPT were developed before the interviews, and these served as structure for each interview (see Appendix F). All interviews occurred after the study was completed. A lap-top computer was used to record statements made by the teachers.

Materials

Problem Solving

The curriculum used for problem-solving instruction was Solving Division Equations: An Algebra Program for Teaching Students with Learning Problems (Mercer et al., 1994; see Appendix G). This curriculum was developed to help students learn and understand the process of solving division equations and algebra word problems that require division equations to solve. The curriculum is comprised of 12 lessons. Each lesson features a sample dialogue for the teacher and contains goals for the lesson, materials needed to complete the lesson, an advanced organizer which orients the students to what will be covered in that lesson, a

describe and model section which outlines the components to be taught in each lesson, a guided practice section which provides teacher dialogue and step-by-step directions to help students complete the problems for that lesson, and worksheets for students to practice the presented skills independently.

The problem-solving curriculum uses a direct instruction format which provides dialogue for the teacher to present the material as well as precisely ordered steps and clear instructions which direct the teacher during presentation. A critical component of the curriculum is the inclusion of three learning strategies which help students organize and remember the steps needed to solve particular problems. Additionally, the curriculum begins lesson one with concrete manipulatives and progressively moves toward the use of more abstract constructs throughout the 12 lessons.

Students sign a learning contract in which they agree to learn how to solve division equations, and teachers sign a contract in which they agree to do whatever they can to help the students learn to solve division equations. This curriculum also includes a pretest/posttest assessment format. Students take a pretest over material that will be covered in the curriculum. The pretest score indicates the students' level of performance prior to exposure to the curriculum. After the completion of all lessons, the students take a posttest which indicates their performance on

content material after exposure to the curriculum. One week after the posttest, students will take a maintenance test to determine retention of the learned material.

CWPT Scoring Materials

Specific materials were required to implement the CWPT intervention. Individual score sheets for students consisted of point total boxes for each day of tutoring. Totaling individual student points based on skill performance provided a system of immediate reinforcement, an important component of CWPT (Hall et al., 1982; Maheady et al., 1987). These score sheets were kept in folders that were easily accessible to students. Team scoring charts were developed to keep team point totals each week in order to name the winning team of the week. The use of these charts provided a system of group contingencies reinforcement, another important component of CWPT (Hall et al., 1982; Maheady et al., 1987). These charts consisted of daily and weekly point total boxes. Recording individual and team point totals provided a second way to check implementation of CWPT (Maheady & Harper, 1987). If student point totals show an accelerating trend both within and across weeks, then these data could strengthen the results of the CWPT implementation checklist ratings. The fact that students are scoring more points indicates that students are becoming more proficient in using CWPT and, therefore, creates additional evidence that CWPT procedures are being followed correctly. Individual student point

totals and team point totals serve as reinforcement for student behavior and were not used as dependent measures for this study.

Procedure

The procedure for this study was divided into four phases. Phase one consisted of inservice for the teachers in the algebra problem-solving curriculum and in classwide peer tutoring. Phase two was student training in classwide peer tutoring procedures. Phase three was implementation of the two treatment conditions. Phase four was posttreatment which consisted of a posttest directly following the completion of all instruction and an administered retention measure following 1 week after posttest. No instruction with the algebra problem-solving curriculum was conducted during the week between the posttest and the retention measure.

Teacher Inservice (Phase One)

Teachers were trained in both the algebra problem-solving curriculum and implementation of classwide peer tutoring procedures. Training in delivering the algebra problem-solving curriculum occurred during one 4-hour session, and CWPT training occurred during one 2-hour session on the same day. Teachers were given the day off with pay and substitute teachers were provided to cover the participant teachers' classes. The training sessions were conducted by this researcher.

Training for the math problem-solving curriculum included reviewing the curriculum lessons as provided by Mercer et al. (1994). The presenter modeled procedures that the teacher was to use to instruct the students. Examples of this included how to manipulate and use the plates and beans as concrete learning tools, saying aloud the steps to the learning strategies, and demonstrating how students would use these strategies to solve the problems. After presentation of the material, participant teachers then role-played instruction.

Training for CWPT followed procedures outlined by Greenwood, Delquadri, and Carta (1988) and consisted of several steps. First, information about CWPT was presented and a rationale for its use for this study was discussed. Second, a video showing students in a real classroom using CWPT was shown. Third, issues in preparing to implement CWPT was presented. These issues included scheduling time, planning for content, designating CWPT pairs and weekly teams, preparing CWPT materials, keeping track of points, and preparing charts and lists for training students to tutor. Fourth, teachers were instructed how to evaluate student progress. Fifth, information regarding training students to tutor was presented. Last, information was discussed regarding how to solve potential problems when implementing CWPT. In addition to these training steps, a videotape of teachers implementing CWPT with students was shown. Through

the videotape, teachers were able to see CWPT actually being used in real classrooms, and they were able to ask questions about specific procedures or situations which arose on the videotape.

Student Training (Phase Two)

Students were trained to use classwide peer tutoring by the participant teachers and by the researcher. Each class in the classwide peer-tutoring intervention was trained for approximately 40 minutes each day for 4 consecutive days. Training consisted of showing the students a videotape that explains classwide peer tutoring and shows an actual classroom of students implementing classwide peer tutoring. Specific procedures were individually explained and modeled by the teacher and the researcher and then students were divided into pairs and they role played each procedure. The classwide peer-tutoring procedures in which the students were trained included (a) peer tutoring social skills, (b) transition from regular seating into tutoring pairs and from tutoring pairs into regular seating, (c) retrieval and return of tutoring materials, (d) practice tutoring, (e) tutee responding behaviors, (f) error correction, and (g) point assignment. On the last day of CWPT training, the students practiced all of the procedures explained, and the researcher monitored the classes to ensure that students satisfactorily completed each of the procedures outlined in the CWPT Implementation Checklist.

Description of Treatments and Implementation (Phase Three)

Each teacher delivered instruction for 6 weeks. Student training for the classwide peer-tutoring groups occurred during the first week. After the pretest, instruction of algebra problem solving began the next class day. Instruction was completed at the end of week 5. The actual instructional days for each teacher ranged from 17 to 18 days depending on particular school district holidays and the number of half-days for particular schools. It should be noted that although 19 instructional days are allowed for in the curriculum, the teachers unanimously decided that 2 particular practice days were not necessary for the students (after lesson 2 and the second practice day after lesson 9). Students were administered the posttest the next class day after instruction was completed. Students did not receive instruction during the sixth week, but all students were administered a maintenance test 1 week after the administration of the posttest. The maintenance test contained the same type problems as the pretest and the posttest including the same percentage of division algebra equations and algebra word problems. Overall, actual instruction in math problem solving occurred for 16 to 18 class days. Student training on CWPT procedures occurred during week 1, and a retention measure was administered 1 week after administration of the posttest. Teachers took part in the study at different times during a 2-1/2-month

period of time during the fall school semester between the months of October and December. Two different treatment conditions were used.

Treatment A. The subjects in treatment group A were instructed using Solving Division Equations: An Algebra Program for Teaching Students with Learning Problems (Mercer et al., 1994). This curriculum uses a direct instruction format which provides a script for the teacher while presenting the material. This curriculum also includes a learning strategy approach to assist students in ordering and remembering the steps needed to solve various math problems. After presentation of the day's material, students were assigned worksheets which they completed to practice the skills covered during the instructional lesson. Several lessons which involved more difficult skills included practice days after the lesson in which students practiced a particular skill an extra day or two.

Treatment B. The subjects in treatment group B were also instructed using Solving Division Equations: An Algebra Program for Teaching Students with Learning Problems (Mercer et al., 1994). After presentation of each day's material, students participated in classwide peer tutoring for practicing the skills covered during the instructional lesson. Several lessons which involved more difficult skills included practice days after the lesson in which students practiced that particular skill an extra day or two.

The single planned experimental difference between Treatment A and Treatment B was the type of skill practice the students used. The students in Treatment A used independent worksheets for practice, and the students in Treatment B used CWPT for skill practice.

Treatment group assignment. Because students were a part of intact math classes, randomized student sampling was not possible. Instead, classes were randomly assigned to different treatments. Additionally, classes were stratified by teacher and by mean class achievement on the math portion of the CTBS. Teachers who participated in the study selected general math classes which they believed would benefit most from the instruction. Classes for each teacher were rank ordered according to current class averages. To assign the classes, a coin was flipped between each pair of successively ranked classes (i.e., between C-1 & C-2 and between C-3 & C-4). Based on the coin flip, classes were assigned to treatment conditions. This random assignment helps ensure that the treatment groups are comparable and that each teacher has classes from each treatment condition (Slavin, 1992).

Posttreatment (Phase Four)

After instructional lessons and practice were completed, a posttest was administered to each student in each treatment group to measure skill acquisition. After 1 week of no algebra instruction or practice, a retention measure which

assessed the same skills was administered to provide some evidence that students retained what they had learned. Retention is defined as the difference score between the maintenance test and the posttest. Several researchers support the use of a 1-week retention measure (Jordan, 1995; Peterson, 1987/88).

Experimental Design and Analysis

The experimental design used in this study is a pretest/posttest group design which allows for assessment of changes in the dependent variable (test score) over time. Analysis includes a 2x2x2 ANOVA with group (CWPT and Independent Practice), student level (at risk & not at risk), and time (pretest and posttest).

Hypotheses

The following section lists each hypothesis and the particular analysis used to evaluate each hypothesis.

Hypothesis #1--There will be no statistically significant difference in performance on algebra problem solving (from pretest to posttest) between treatment groups (CWPT & independent practice. A 2x2 repeated measures analysis of variance (ANOVA) was computed to determine whether any significant differences were present among the levels of experimental treatments. A .05 level of confidence was established to determine whether differences were significant and to reject the null hypotheses.

Hypothesis #2--There will be no statistically significant difference in performance on algebra problem solving (from posttest to maintenance test) between treatment groups (CWPT and independent practice). A 2x2 repeated measures analysis of variance (ANOVA) was computed to determine whether any significant differences were present among the levels of experimental treatments. A .05 level of confidence was established to determine whether differences were significant and to reject the null hypotheses.

Hypothesis #3--There is no statistically significant difference in performance on algebra problem solving (from pretest to posttest) between students classified as at risk and students classified as not at risk. A 2x2 repeated measures analysis of variance (ANOVA) was computed to determine whether significant differences were present between students identified as at risk of math failure and students not identified as at risk of math failure. A .05 level of confidence was established to determine whether differences were significant and to reject the null hypothesis.

Hypothesis 4--There will be no statistically significant difference in performance on algebra problem solving (from posttest to maintenance test) between the at-risk group and the not-at-risk group. A 2x2 repeated measures analysis of variance (ANOVA) was computed to determine whether significant differences were present between students

identified as at risk of math failure and students identified as not at risk of math failure. A .05 level of confidence was established to determine whether differences were significant and to reject the null hypothesis.

Hypothesis #5--There is no statistically significant differences in performance on algebra problem solving from pretest to posttest among four groups (CWPT/at risk, CWPT/not at risk, Independent Practice/at risk, Independent Practice/not at risk) as determined by the interaction between treatment group and at-risk classification. A 2x2x2 repeated measures ANOVA was computed to determine whether any significant differences were present among the four groups. A .05 level of confidence was established to determine whether differences were significant and to reject the null hypothesis.

Hypothesis #6--There will be no statistically significant differences in retention of algebra problem solving from posttest to maintenance test among the four groups (CWPT/at risk, CWPT/not at risk, Independent Practice/at risk, Independent Practice/not at risk) as determined by the interaction between treatment group and at-risk classification. A 2x2x2 repeated measures ANOVA was computed to determine whether any significant differences were present among the four groups. A .05 level of confidence was established to determine whether differences were significant and to reject the null hypothesis.

Social Validity

An important consideration in evaluating the efficacy of any instructional strategy is the response of the teachers and students involved in using the instruction. Adopting instructional procedures that are not liked by teachers and/or students may result in the failure of that instruction since the participants will be adversely affected by their negative attitudes. Surprisingly, very few commercial materials are ever field-tested. Sprick (1986) reported that less than 3% of commercial materials are field-tested before being published. By asking students and teachers their opinions regarding their "in-field" use of the CWPT intervention, it is hoped that this information can better help appraise the efficacy of the instruction.

Students in the CWPT treatment group completed a short questionnaire after the maintenance test that assessed their attitudes about the CWPT intervention. Frequencies and percentages were calculated for each question on the survey.

Teachers were informally interviewed to assess their perceptions of CWPT and its use with higher order thinking skills. Teachers were interviewed individually after the intervention and maintenance test had been completed.

CHAPTER IV RESULTS

Introduction

The purpose of this study was to investigate the effects of classwide peer tutoring on the acquisition of algebra problem-solving skills with middle school students. The general question posed in this study was as follows: Do general math students learn to solve higher order thinking skills better using classwide peer tutoring or using independent practice? To examine this question, the performance of the classwide peer tutoring group, which received instruction on solving basic algebra skills, was compared to the performance of the independent practice group which received the same instruction on solving basic algebra problem-solving skills. The effects of both types of skills practice on learning to solve basic algebra skills was assessed and compared. In addition to this analysis, the performance of students classified at risk of math failure was compared to the performance of students classified not at risk of math failure.

This chapter is divided into five sections and presents data acquired in the study that will answer the experimental questions. First, results from measures taken to insure procedural reliability are reported. Second, demographic characteristics of the study participants are described.

Third, the univariate analysis of variance results are discussed. Fourth, results of repeated measures ANOVA are reported in relation to the hypotheses. Fifth, related findings are reported.

Reliability of Measurement and Instructional Procedures

Procedures were implemented during the study to insure reliability of measurement procedures, instructional procedures, and student practice implementation. A key was provided to test graders to help standardize test grading. Teachers were observed to insure instructional procedure reliability. Students and teachers were observed to insure CWPT and independent practice implementation reliability.

Instructional Procedures

Teachers were observed to determine whether the major components of the instructional curriculum (advanced organizer, demonstrate and model component, guided practice component, and student practice) were being implemented. Each teacher was observed at least two times during the study to determine whether each of the major instructional components were implemented during the instructional phase of the lesson. Each teacher was observed to include each instructional component during the instructional phases with 100% accuracy. Teachers were also interviewed regarding their methods of instruction. All teachers indicated that they used the algebra curriculum supplied by the researcher to guide their instruction. Teachers indicated that they

followed the instructional lessons in sequence except that they omitted two specific practice lessons. These omitted lessons were practice days with little actual instruction and the teachers did not believe that the students needed this additional practice time at this point in the instructional sequence. The teachers indicated that they generally did not read the scripts in the curriculum verbatim but used the scripts as guides during instruction. Teachers replied that they maintained the integrity of each lesson by including each instructional component (advanced organizer, demonstrate and model, guided practice, and student practice) and by using the examples supplied by the curriculum for each lesson. These claims were verified by observers.

Test Grading

Pretests, posttests, and maintenance tests were graded by the investigator, fellow doctoral students in special education at the University of Florida, and one graduate of the University of Florida who had a minor in education. An answer key was given to each scorer. Scorers were instructed to circle the incorrect answers and record the number of correct answers for each subsection (division equations and word problems) and for the total test.

Classwide Peer-Tutoring Implementation

Observers included the investigator, one special education doctoral student, two proteach special education students, and a graduate of the University of Florida who

minored in education. Appendix D presents an example of the checklist used for observation. Each CWPT group was observed at least two times. Interrater reliability was monitored by pairing two observers for at least one observation for each CWPT group. This was not possible for one CWPT class because this class was in a school outside of the county and two raters were not available to make the trip on the scheduled observation days. Only one rater was available for this class's observation days. The mean total integrity score for all classes observed was 92%. This figure indicates that teachers and students performed an average of 92% of important CWPT behaviors during observation. The level of implementation fidelity in this study exceeds the minimum of 85% cited by other CWPT researchers (Greenwood et al., 1989; Greenwood et al., 1992). Raters who observed the same classes agreed with each other's observations at a rate of 90%. This represents an interrater reliability coefficient of .90.

Demographic Characteristics of Participants

A total of 14 classrooms from three middle schools participated in the study. The total number of subjects who completed a pretest, posttest, and maintenance test equaled 262. The CWPT group totaled 140 students, and the independent practice group totaled 122 students. Of the total number of students, 133 (51%) were female and 129 (49%) were male. The racial makeup of the total included 189 (72%)

white students, 54 (21%) African-American students, and 18 (7%) Hispanic students. Lunch status was primarily paid lunch. One-hundred eighty-nine students (72%) paid for their lunch; 9 students (3%) paid a reduced fee for lunch; and 64 students (24%) had free lunch.

Most of the students (249) had no identified disability; 3 students were identified as gifted; 8 students were identified with a learning disability; and 2 students were identified as speaking English as a second language (ESOL). Examining students' stanine scores on the previous year's total math section of standardized achievement tests (California Test of Basic Skills or California Achievement Test) revealed that 23 (10%) students had scores between 1-3 stanines, 172 (75%) students had scores between 4-6 stanines, and 35 (15%) students had scores between 7-9 stanines. Table 1 presents a descriptive summary of students in both treatment groups.

Preexisting differences between the two treatment groups were determined by conducting chi-square analyses by gender, ethnicity, age, exceptional education (ESE) label, socioeconomic status (lunch status), at-risk status, teacher, and school. For each analysis the 0.05 level of significance was used.

Chi-square tests (χ^2) tests were used to compare the two groups by gender, ethnicity group, age, lunch status, ESE label, at-risk classification, teacher, and school. The χ^2

Table 1
Descriptive Information for Treatment Groups

Descriptors		Group			
		CWPT		Indep. Pract.	
		n	%	n	%
Gender	male	65	46.4	64	52.5
	female	75	53.6	58	47.5
Ethnicity	white	99	70.7	90	74.4
	black	28	20.0	26	21.5
	Hispanic	13	9.3	5	4.1
Lunch status	free	33	23.6	31	25.4
	fee reduced	5	3.6	4	3.3
	full-priced	102	72.9	87	71.3
Special education					
Program status					
	disability	5	3.6	5	4.1
	none	135	96.4	117	95.9
Age					
	12-13	103	78.0	89	75.0
	14-15	29	22.0	30	25.0
Risk Category					
	at risk	57	41.0	42	34.0
	not at risk	83	59.0	80	66.0

Note. Ages of 10 students could not be obtained resulting in lower totals for both treatment groups in both age ranges.

revealed no differences between the groups by gender ($\chi^2 = .949$, 1, $p = .330$). The percentage of females in the CWPT group (54%) is not significantly different than the percentage of females in the independent practice group (48%).

The χ^2 revealed no differences between the groups by ethnicity ($\chi^2 = 2.689$, 2, $p = .261$). The percentage of African-American students (20%), Hispanic students (9%), and white students (71%) in the CWPT group is not significantly different from the percentage of African-American students (22%), Hispanic students (4%), and white students (74%) in the independent practice group.

The χ^2 revealed no differences between the groups by age of students ($\chi^2 = .400$, 3, $p = .940$). The percentage of students who were age 12 (2%), age 13 (76%), age 14 (20%), and age 15 (2%) in the CWPT group is not significantly different from the percentage of students who were age 12 (3%), age 13 (72%), age 14 (24%), and age 15 (2%) in the independent practice group.

Lunch room status is used to calculate overall SES for a school. The χ^2 did not reveal significant differences between the groups by lunch status ($\chi^2 = .128$, 2, $p = .938$). The percentage of students who received free lunch in the CWPT group (24%) was not significantly different from the percentage of students who received free lunch in the independent practice group (25%).

All students included in the disability category were classified as having a learning disability except two students, who are classified as ESOL (English as a second language). The two ESOL students were included in the disability category because they were experiencing

significant difficulties in their math class as a result of their English language deficits. In addition, three students who are classified as gifted were included in the no-disability category. The χ^2 did not reveal significant differences between the groups by ESE label ($\chi^2 = .049$, 1, $p = .824$). The percentage of students who are identified as having a disability in the CWPT group (4%) is not significantly different from the percentage of students identified as having a disability in the independent practice group (4%).

The χ^2 did not reveal significant differences between the groups by at-risk status ($\chi^2 = 1.096$, 1, $p = .295$). The percentage of students classified as at risk of math failure in the CWPT group (41%) is not significantly different from the percentage of students classified as at risk of math failure in the independent practice group (34%).

The χ^2 did not reveal significant differences between the groups by teacher ($\chi^2 = .786$, 3, $p = .853$). The CWPT and independent practice groups are considered to be comparable in numbers of students for each of the four teachers who participated in the study.

The χ^2 did not reveal significant differences between the groups by school ($\chi^2 = .125$, 2, $p = .939$). The CWPT and independent practice groups were considered to be comparable in numbers of students for each of the three schools which participated in the study.

Univariate Analysis

A univariate analysis was performed on pretest scores to determine if there were differences between the groups. No significant differences were found between the CWPT group or the independent practice group on the pretests ($t = -.8484$, 260, $p = .3970$). Therefore, the two groups were considered to be comparable in ability to solve basic algebra problems (division equations and word problems) at the time of the pretest. Table 2 provides the means from the pretest by group.

Table 2

Groups Means on Pretest

Group	N	Mean	t	p-value
CWPT	140	7.91		
Ind. Prac.	122	8.44	-.8484	.3970

Note. Total number of test items = 20.

*Significant at the $p < .05$ level.

Univariate analyses were also performed on the posttest and the maintenance test. No significant differences were found between the CWPT group and the independent practice group on the posttest ($t = .6668$, 211, $p = .5056$). No significant differences were found between the CWPT group and the independent practice group on the maintenance test ($t = .3292$, 228, $p = .7423$). The means of the pretest scores,

posttest scores, and maintenance test scores are summarized in Table 3.

Table 3

Means for Treatment Groups on Pretest, Posttest, and Maintenance Test

<u>Measure</u>	<u>Group Means</u>	
	CWPT	Indep. Prac.
Pretest	7.91	8.44
Posttest	17.34	17.06
Maintenance	17.37	17.23

Univariate analysis was performed on the pretest scores of the at-risk groups and revealed significant differences between the at-risk group and the not-at-risk group, ($t = -5.5891$, 260, $p = .0000$). The performance of the not-at-risk group was significantly higher than the performance of the at-risk group. This finding suggests that students classified as not at risk of math failure had more skill in solving basic algebra problems than students classified as not at risk of math failure at the beginning of the study. Table 4 presents the means for the pretest by at-risk classification.

Additional univariate analyses for posttests and maintenance tests revealed that means were significantly higher for the not-at-risk group compared to the means for

Table 4

Groups Means on Pretest

Group	N	Mean	t	p-value
At Risk	99	6.02		
Not At Risk	163	9.45	-5.5891	.0000*

*Significant at the $p < .05$ level.

the at-risk group ($t = -5.5887$, 136, $p = .0001$ for the posttest, and $t = -4.7142$, 134, $p = .0001$ for the maintenance test). The means for the pretest posttest, and maintenance test are summarized in Table 5.

Table 5

Means for At-risk Groups on Pretest, Posttest, and Maintenance Test

<u>Measure</u>	<u>Group Means</u>	
	At risk	Not at risk
Pretest	6.02	9.45
Posttest	15.63	18.17
Maintenance	15.92	18.15

Hypotheses

Analysis was conducted to investigate the hypotheses. The repeated measures ANOVA procedure was used to test the hypotheses. Keppel (1982) stated that the repeated measures analysis is the most common design used to study practice, learning, and transfer. The repeated measures ANOVA was selected to examine the three dependent measures

and therefore reject or fail to reject the six null hypotheses.

Hypothesis 1

H1: There will be no statistically significant difference in performance on algebra problem solving (from pretest to posttest) between treatment groups (CWPT & independent practice).

There are no significant differences in performance between treatment groups from pretest to posttest, $F(1, 260) = 1.66$, $p = .1993$; that is, there are no significant differences in performance from pretest to posttest between the CWPT group and the independent practice group. However, there are significant differences between pretest and posttest scores for all students regardless of treatment group. Performance for all students on the posttest is significantly higher than performance on the pretest regardless of treatment group. Table 6 summarizes the repeated measures ANOVA from pretest to posttest. Based on these findings Hypothesis 1 is not rejected. Table 7 provides a summary of the group means on the posttest.

Hypothesis 2

H2: There will be no statistically significant difference in performance on algebra problem solving (from posttest to maintenance test) between treatment groups (CWPT & independent practice).

Table 6

Repeated Measures ANOVA for Pretest to Posttest

Source	df	F value	p value
Trt	1	0.08	.7714
Error	260		
Time	1	800.44	.0001*
Time*Trt	1	1.66	.1993
Error(Time)	260		

*Significant at the $p < .05$ level.

Table 7

Groups Means on Posttest

Group	N	Mean	t	p-value
CWPT	140	17.34	.6668	.5056
Ind. Prac.	122	17.06		

*Significant at the $p < .05$ level.

There are no significant differences in performance from posttest to maintenance test between students in the treatment groups, $F(1, 260) = 0.21$, $p = .6475$. Table 8 provides results of the repeated measures ANOVA by treatment group. Table 9 provides a summary of the group means on the maintenance test. Based on these findings, Hypothesis 2 is not rejected. In addition, all students regardless of treatment group, maintained their posttest score, $F(1, 260) = 0.41$, $p = .5228$.

Table 8

Repeated Measures ANOVA for Pretest to Posttest

Source	df	F value	p value
Trt	1	.30	.5848
Error	260		
Time	1	.41	.5228
Time*Trt	1	.21	.6475
Error (Time)	260		

*Significant at the $p < .05$ level.

Table 9

Groups Means on Maintenance Test

Group	N	Mean	t	p-value
CWPT	140	17.37	.33	.7423
Ind. Prac.	122	17.23		

*Significant at the $p < .05$ level.

Hypothesis 3

H3: There will be no statistically significant difference in performance on algebra problem solving from pretest to posttest between the at-risk group and the not-at-risk group.

No significant differences are found between the performance of students classified as at risk of math failure and students classified as not at risk of math failure from pretest to posttest, $F(1, 260) = 1.83$, $p = .1770$; that is, there are no significant differences in performance from

pretest to posttest between students classified as at risk of math failure and students classified as not at risk of math failure. Table 10 provides a summary of the results of the repeated measures ANOVA for pretest to posttest by at-risk classification. Table 11 provides an analysis of the means of each group on the posttest. Based on these findings, Hypothesis 3 is not rejected. There is a significant improvement from pretest to posttest for all students regardless of treatment group, $F(1, 260) = 779.86$, $p = .0001$.

Table 10

Repeated Measures ANOVA for Pretest to Posttest

Source	df	F value	p value
Risk Category	1	55.44	.0001*
Error	260		
Time	1	779.86	.0001*
Time*Risk	1	1.83	.1770
Error (Time)	260		

*Significant at the $p < .05$ level.

Table 11

Groups Means on Posttest

Group	N	Mean	t	p-value
At Risk	99	15.63	-5.59	.0001*
Not At Risk	163	18.17		

*Significant at the $p < .05$ level.

Hypothesis 4

H4: There will be no statistically significant differences in performance on algebra problem solving from posttest to maintenance test between the at-risk group and the not-at-risk group.

There are no statistically significant differences in performance on algebra problem solving from posttest to maintenance test between the at-risk group and the not-at-risk group, $F(1, 260) = .97$, $p = .3254$. Moreover, performance on algebra problem solving from posttest to maintenance for all students regardless of at-risk classification is not significantly different. Table 12 provides a summary of the results of the repeated measures ANOVA for posttest to maintenance test by at-risk group. Table 13 provides an analysis of the means of each group on the maintenance test. Based on these findings, Hypothesis 4 is not rejected.

Hypothesis 5

There will be no statistically significant difference in performance on algebra problem solving from pretest to posttest among four groups (CWPT/at risk; CWPT/not at risk; Independent Practice/at risk; Independent Practice/not at risk) as determined by the interaction between treatment group and at-risk classification.

There are no statistically significant interaction effects on performance from pretest to posttest between

Table 12

Repeated Measures ANOVA for Posttest to Maintenance Test by At-Risk Group

Source	df	F value	p value
Risk Category	1	40.75	.0001*
Error	260		
Time	1	.69	.4056
Time*Risk	1	.97	.3254
Error (Time)	260		

*Significant at the $p < .05$ level.

Table 13

Groups Means on Maintenance Test

Group	N	Mean	t	p-value
At Risk	99	15.92	-4.71	.0001*
Not At Risk	163	18.14		

*Significant at the $p < .05$ level.

treatment group and at-risk classification, $F(1, 258) = .82$, $p = .3668$; that is, there are no significant differences in performance between the four groups (CWPT/at risk, CWPT/not at risk, Independent Practice/at risk, Independent practice/not at risk). There is significant improvement overall for the 262 students but this improvement is not a factor of either treatment group, at-risk classification, or any combination of the two variables. Table 14 provides a summary of the repeated measures ANOVA for interaction

effects. Table 15 provides an analysis of the means of the four groups. Based on the findings, Hypothesis 3 is not rejected.

Table 14

Repeated Measures ANOVA for Pretest to Posttest

Source	df	F value	p value
Time	1	768.25	.0001*
Time*Trt	1	.87	.3520
Time*Risk	1	1.85	.1752
Time*Trt*Risk	. 1	.82	.3668
Error (Time)	258		

*Significant at the $p < .05$ level.

Table 15

Groups Means on Posttest by Treatment/Risk Group Interaction

Group	N	Mean	t	p-value
CWPT/A-R	57	16.00	-4.68	.0001*
CWPT/NA-R	83	18.26		
IP/A-R	42	15.12	-3.52	.0009*
IP/NA-R	80	18.08		

*Significant at the $p < .05$ level.

Hypothesis 6

H6: There will be no statistically significant differences in retention (from posttest to maintenance test) of algebra problem solving among the four groups

(CWPT/at risk, CWPT/not at risk, Independent Practice/at risk, Independent Practice/not at risk) as determined by the interaction between treatment group and at-risk classification.

There are no significant differences between the four groups as determined by interaction effects, $F = (1, 258) = 0.00$, $p = .9779$; that is, the performance of students from posttest to maintenance test is not significantly different among the four groups (CWPT/at risk, CWPT/not at risk, Independent Practice/at risk, Independent Practice/not at risk). Performance on the maintenance test is not a factor of treatment group, at-risk classification, or any combination of the two variables. Table 16 summarizes the repeated measures ANOVA from posttest to maintenance test. Table 17 provides an analysis of the means for the four groups. Based on these findings, Hypothesis 6 is not rejected.

It should be noted that there is no statistically significant difference in the performance of students on the posttest and their performance on the maintenance test, $F(1, 258) = .75$, $p = .3881$. Therefore, student performance did not significantly change after 1 week of no instruction on algebra problem-solving skills. Students in all groups were able to retain their performance level from posttest to maintenance test.

Table 16

Repeated Measures ANOVA for Posttest to Maintenance Test

Source	df	F value	p value
Time	1	.75	.3881
Time*Trt	1	.25	.6195
Time*Risk	1	1.01	.3155
Time*Trt*Risk	1	0.00	.9779
Error (Time)	258		

*p<.05.

Table 17

Groups Means on Maintenance by Treatment/Risk Group Interaction

Group	N	Mean	t	p-value
CWPT/A-R	57	16.23	-3.53	.0007
CWPT/NA-R	83	18.16		
IP/A-R	42	15.50	-3.18	.0024
IP/NA-R	80	18.14		

*p<.05.

Related Findings

Further analyses were conducted to answer questions related to the study but not included in the hypotheses. These questions included the following:

1. How did students perform in terms of ability, age, gender, SES, pretest performance, teacher, and minority status?

2. Are specific skill areas more or less affected by the intervention?
3. Do comparison groups perform differently according to specific skill areas?
4. What were students' and teachers' reactions to the treatment?

Achievement for Students by Ability, Age, Gender, SES, Pretest Performance, Teacher, Minority Status

The data were analyzed in terms of performance of students by ability, age, gender, SES status, pretest scores, teacher, or minority status. These data are summarized in Table 18.

For overall achievement, all students demonstrated improvement from pretest to posttest. No significant differences are found between treatment groups (CWPT & Independent Practice), between students with disabilities and students without disabilities, and between female and male students on pretest, posttest, and maintenance test.

Significant differences are found to exist between at-risk groups on pretest, posttest, and maintenance test. At-risk students scored significantly lower on the pretest than the not-at-risk students. Although significant differences between at-risk groups remains on posttest and maintenance test, the amount of improvement for both groups is actually greater for the at-risk group. The mean difference between pretest and posttest for the at-risk group is 9.61 while the mean difference between pretest and

posttest for the not-at-risk group is 8.72. Additionally, mean difference between pretest and maintenance test for the at-risk group is 9.90 while the mean difference between pretest and maintenance test for the not-at-risk group is 8.70. One explanation for these results is that some students in the not-at-risk group scored 20 out of 20 and could have scored higher if more items were on the test. Such a situation could have created a ceiling effect that kept the mean difference between pretest and posttest down for the not-at-risk group as well as the mean difference between pretest and maintenance test.

Significant differences exist between pretest scores of white and minority students. White students had a higher mean score than the minority students. Interestingly, there are no significant differences between posttest and maintenance mean scores for the same groups. This indicates that while minority students scored significantly lower at pretest, their performance compared to the white students improved on posttest and maintenance test.

Significant differences exist between mean pretest, posttest, and maintenance test for age group. Students in the 12- to 13-year-old age group scored higher than students in the 14- to 15-year-old age group on all tests. The fact that students in the older age group missed more than three items more on the pretest than the younger age group

indicates that the older students as a group started with fewer algebra problem-solving skills.

Significant differences on pretest, posttest, and maintenance test are found between students who receive free or reduced lunch and students who paid for their lunch. Students who receive free or reduced lunch scored consistently lower on these tests.

Finally, significant differences are found between the students who scored high on the pretest (10-20 items correct) and students who scored low on the pretest (0-9 items correct). While the mean difference equaled 8.96 items on pretest for these groups, the mean differences for posttest and maintenance test were only 1.94 items and 1.88 items respectively. These results indicate that despite the fact that 61% of the students in the study were in the low pretest group, these students substantially closed the gap in skill level by the end of the curriculum.

A general trend reflected in these data is that students who started with fewer algebra problem-solving skills at pretest (at-risk students, minority students, students with disabilities, older students, students on free or reduced lunch, and low pretest students) substantially improved their performance in relation to the students who scored higher than them on pretest. It should be emphasized that all students improved substantially, but students with fewer algebra problem-solving skills at the

beginning of the curriculum seemed to benefit to a greater extent from the instruction than the students with greater algebra problem solving skills at pretest. Table 18 summarizes overall mean scores on pretest, posttest, and maintenance test for all students, by treatment group, by at-risk classification, by ethnicity, by disability status, by age group, by lunch status, by pretest performance, and by gender.

Table 18

Overall Achievement Means on Pretest, Posttest, and Maintenance Test

Category	N	Pretest	Posttest	Maintenance
All subjects	262	8.16	17.21	17.30
CWPT	140	7.91	17.34	17.37
Ind. Practice	122	8.44	17.06	17.23
At Risk	99	6.02*	15.63*	15.92*
Not At risk	163	9.45	18.17	18.15
White	189	8.65*	17.35	17.43
Minority	72	6.74	16.80	16.93
Disability	10	5.60	17.10	17.80
No Disability	252	8.26	17.21	17.29
Age (12-13)	192	8.60*	17.71*	17.69*
Age (14-15)	59	6.54	15.91	16.22
Paid Lunch	189	9.05*	17.59*	17.67*
Free/Reduced	73	5.85	16.23	16.36
Hi Pretest(10-20)	101	13.66*	18.40*	18.46*
Low Posttest(0-9)	161	4.70	16.46	16.58
Female	133	7.80	17.09	17.02
Male	129	8.52	17.33	17.59

* = significant differences @ 0.05.

Additional analysis was completed regarding achievement of treatment groups (CWPT & Independent Practice) based on demographic classifications. No significant differences are found to exist between treatment groups by the following demographic classifications: white, minority, high pretest, low pretest, low age group (age 12-13), females, males, paid lunch, and free/reduced lunch. In other words, the mean test scores of white students using CWPT did not differ significantly from the mean test scores of white students using independent practice. The same finding of no significant differences is true for CWPT and independent practice groups based on minority status, high pretest performance, low pretest performance, low age group (12-13), gender, paid lunch status, and free/reduced lunch status.

The exception to this trend of no significant difference between treatment groups was the mean pretest scores of the high age students (age 14-15). Significant differences are found between the CWPT group and the independent practice group on mean pretest scores of 14- and 15-year-old students. Significant differences are not found between mean posttest scores or mean maintenance test scores. While students in the CWPT group scored significantly lower on the pretest, their scores on the posttest and maintenance test were actually higher than the scores of the independent practice group. This situation is surprising because one might assume that students who begin with greater skill in an area would

have an advantage in learning skills compared to students who started with fewer skills. This finding indicates that the CWPT group of 14- and 15-year-old students developed more algebra problem-solving skills by measure of the posttest and the maintenance test than did the independent practice group. The differences between posttest and maintenance test scores between the CWPT and independent practice groups are not significant, so the increased algebra solving skill development by the CWPT 14- and 15-year-old students may be due to chance. Table 19 summarizes the mean scores on pretest, posttest, and maintenance test between treatment groups based on demographic classification.

Further analysis was conducted to examine achievement of students by at-risk classification based on treatment group assignment, pretest performance, and various demographic classification. No significant differences are found for the at-risk students by treatment group, ethnicity, or age group. These findings indicate that the performance of students at risk of math failure did not differ due to these variables. Significant differences are found between high pretest performers and low pretest performers, for pretest, posttest, and maintenance test. This finding is consistent with the findings for all students reported in Table 18. In addition, significant differences are found between females and males at risk of math failure on posttest and maintenance test. Female students scored significantly lower on posttest and

Table 19

Achievement by Treatment Group Based on Demographic Classification

Category	N	Pretest	Posttest	Maintenance
White CWPT	99	8.33	17.61	17.69
White Ind Prac	90	9.00	17.08	17.16
Minority CWPT	41	6.88	16.71	16.61
Minority Ind Prac	31	6.55	16.94	17.35
Hi Pre CWPT	99	13.90	18.54	18.64
Hi Pre Ind Prac	69	13.45	18.28	18.30
Age(12-13) CWPT	103	8.58	17.69	17.48
Age(12-13) Ind Pr	89	8.63	17.74	17.93
Age(14-15) CWPT	29	5.21*	16.45	16.97
Age(14-15) Ind Pr	30	7.83	15.40	15.50
Female CWPT	75	7.43	17.21	17.19
Female Ind Prac	58	8.29	16.93	16.81
Male CWPT	65	8.46	17.49	17.58
Male Ind Prac	64	8.58	17.17	17.61
Paid CWPT	102	8.52	17.72	17.74
Paid Ind Prac	87	9.67	17.42	17.60
Free/Reduce CWPT	38	6.26	16.32	16.39
Free/Reduce In Pr	35	5.40	16.14	16.31

* = significant differences @ 0.05.

maintenance test than male students. This finding is not consistent with the results of gender differences for all

students regardless of at-risk classification (see Table 18). Table 20 summarizes the mean test scores for at-risk students by treatment group, ethnicity, age group, pretest performance, and gender.

Table 20

Achievement of Students Classified At Risk of Math Failure

Category	N	Pretest	Posttest	Maintenance
All At Risk	99	6.02	15.63	15.93
CWPT	57	6.38	16.00	16.23
Ind Prac	42	5.52	15.12	15.50
White	63	6.48	16.10	16.10
Minority	36	5.22	14.80	15.61
Age(12-13)	63	6.51	16.25	16.46
Age(14-15)	31	4.71	14.74	14.84
Hi Pretest	20	12.90*	17.95*	18.25*
Low Pretest	79	4.28	15.04	15.33
Female	43	5.88	14.49*	14.74*
Male	56	6.12	16.50	16.82

* = significant differences @ 0.05.

Analysis of students not at risk of math failure revealed no significant differences between treatment groups (CWPT & independent practice), by ethnicity, and by age group; that is, the performance of students classified as not

at risk of math failure did not differ based on treatment group, ethnicity, or age group.

Significant differences are found for mean pretest scores and mean maintenance test scores between high and low pretest performance groups. It is interesting to note that there are significant differences between pretest performance groups (high performers vs. low performers) on the pretest. The low pretest group mean score is 8.74 points (out of 20 items) lower than the high pretest group, but the scores between the groups are not significantly different at posttest. This finding indicates that the low pretest performers' overall achievement was greater than that for the high pretest performers. Although the mean score for the low pretest group was not higher than the mean score for the high pretest group, the amount of achievement relative to pretest performance was greater.

Significant pretest differences are also found between males and females classified as not at risk of math failure. This finding indicates that the females in the not-at-risk group had fewer algebra solving skills than the males before instruction. Significant differences are not found between the two groups on posttest and maintenance test. This finding indicates that the females in the not-at-risk group performed as well as the males after instruction despite starting with fewer skills at the beginning of instruction. Table 21 summarizes the mean test scores for the not-at-risk

group by treatment group, ethnicity, age group, pretest performance, and gender.

Table 21

Achievement of Students Classified as Not At Risk of Math Failure

Category	N	Pretest	Posttest	Maintenance
All Not At Risk	163	9.45	18.17	18.15
CWPT	83	8.95	18.26	18.16
Ind Prac	80	9.98	18.08	18.14
White	126	9.74	17.98	18.10
Minority	36	8.25	18.80	18.25
Age(12-13)	129	9.74	17.98	18.10
Age(14-15)	36	8.25	18.80	18.25
Hi Pretest	81	13.85*	18.52	18.52*
Low Pretest	82	5.11	17.83	17.78
Female	90	8.72*	18.33	18.11
Male	73	10.36	17.97	18.19

* = significant differences @ 0.05.

Skill Areas

Skill areas on the pretest, posttest, and maintenance tests were categorized into two areas: division equations and word problems. A t-test was used to compare scores on the posttest to determine if there were any significant differences in these areas. No significant differences between treatment groups (CWPT & Independent Practice) were

found on performance for solving division equations on pretest, posttest, and maintenance test. Student performance on both subskills did not differ regardless of treatment group. Table 22 provides a summary of the performance of CWPT and independent practice groups in both skill areas on the posttest.

Table 22

Comparison of Skill Area Performance on Posttest by Treatment Group

Skill	# of Items	<u>CWPT Group</u> <u>Group</u> (n=140)		<u>Ind. Prac.</u> <u>Group</u> (n=122)		t	df	p
		Mean	SD	Mean	SD			
Div.Equa. (14)		12.89	1.61	12.70	2.67	.68	193.1	.6366
Word Pro. (6)		4.46	1.57	4.36	1.71	.48	260	.6346

In contrast to relatively equal achievement on algebra subskills by treatment group, significant differences in achievement on subskills are found by at-risk classification. Significant differences are found between at-risk groups on pretest, posttest, and maintenance test. In all areas, the at-risk group scored significantly lower than the not-at-risk group. One additional characteristic of the data should be noted. Although students at risk of math failure scored significantly lower than students not at risk of math failure on all subskills for all tests, the relative achievement of students at risk of math failure from pretest to posttest (mean increase of 8.07 items correct) was greater than the

relative achievement of students not at risk of math failure (mean increase of 7.17 items correct). Table 23 provides a summary of the posttest performance of at-risk groups in the two skill areas.

Table 23

Comparison of Skill Area Performance on Posttest by At-Risk Group

Skill	# of Items	<u>At-Risk Group</u> (n=99)		<u>Not-at-risk Group</u> (n=163)		t	df	p
		Mean	SD	Mean	SD			
Div. Equa. (14)		11.97	2.77	13.30	1.51	-4.40	133.8	.0001
Word Pro. (6)		3.65	1.85	4.87	1.30	-5.74	156.9	.0001

Social Validation Measures

Social validity of the CWPT instruction was measured through questionnaires from students and interviews with teachers. This section includes a summary of the social validation data.

Student Questionnaires

Students in the CWPT classes (n=155) completed a 17-item Likert-scale questionnaire (Maheady, Harper, Mallette, & Winstanley, 1991) which assessed their opinions regarding different aspects of CWPT. The questionnaire was slightly modified to address the specific content of the algebra curriculum. Questions focus on five areas related to CWPT and its implementation. These areas include students'

perceptions regarding the suitability of using CWPT with students, specific CWPT procedures, its effectiveness in helping students to learn algebra problem-solving skills, how well students like working with a partner, and the social effects of CWPT.

Suitability of using CWPT with students. Students generally believe that CWPT is a suitable instructional strategy. Fifty-two percent of students responded that they would *definitely* use CWPT if they were a teacher. Forty-three percent of students responded that *maybe* they would use CWPT. Sixty-one percent of students thought that it was appropriate to use CWPT in other classes, while 32% said that *maybe* it is appropriate. Seventy-four percent of students believe CWPT is fair. Seventeen percent of the students believed CWPT was *very unfair*. Ninety-two percent of students believe that CWPT *maybe* or *definitely* should be done. Ninety-five percent of students think that CWPT treated them kind of nice or very nicely. Eighty-four percent of students believe that CWPT is not harmful at all.

Students seem to think that CWPT is generally a suitable type of instruction. The majority of students find CWPT fair, that it treats them nicely, and that they would use it if they were a teacher.

Student opinions regarding CWPT procedures. Ninety-one percent of students thought the things they did using CWPT were O.K. or that they liked them very much. Forty-nine

percent of students liked the use of teams very much, while 37% moderately liked it. Eighty-two percent of students either moderately liked earning points or liked earning points very much.

Students appear generally to like CWPT procedures. They like earning points and using teams almost equally. Their overall reaction to the procedures is generally positive but not enthusiastically positive.

The effectiveness of CWPT for learning algebra problem solving. Ninety percent of students think that CWPT helped them learn to solve division equations pretty well or very well. Eighty-eight percent think that CWPT helped them learn to solve algebra word problems pretty well or very well. These data indicate that students overwhelmingly believe CWPT helped them to learn both division equations and word problems and they believe there is little difference in its effectiveness for teaching both skills.

Social effects of CWPT. Students believe CWPT is somewhat helpful in making friends. Forty-eight percent of students believe that CWPT helped them some to become better friends with other students, while 25% of students believed CWPT helped them a lot. Fifty-four percent of students think students to some degree were more friendly to them, but 25% of students did not think this at all. In terms of whether students think CWPT makes other students more friendly to them or makes some students think they are smarter now, 46%

to 47% believe this is true to some degree. However, 21% to 27% believe this is not true at all.

Students' overall opinion of the effect CWPT has on them socially is somewhat mixed. While about half of students believe CWPT helps them socially to some degree, a significant portion of the students (approximately 25%) believe this is not true at all. At best, students perceive that CWPT has at most a modestly positive effect on them socially.

When students were asked what was their overall opinion of CWPT, 35% of students said they *like it a lot*, while 49% thought it was *O.K.* Only 8% of students did not like CWPT at all. The general trend in student responses is that students have positive regard for it; some have enthusiastic regard for it, while a larger number are more modest in their praise.

Teacher Interviews

The researcher communicated with teachers periodically throughout the study through either on-site visits or telephone calls. This communication allowed teachers to ask questions and give feedback during the study. Additionally, teachers were informally interviewed after completion of the study regarding their perceptions of the interventions and their recommendations for revisions or future implementation.

The discussion regarding teacher reactions to using CWPT is divided into nine areas: (a) positive aspects, (b)

negative aspects, (c) implementation requirements, (d) teacher friendliness, (e) CWPT's effectiveness in helping students to learn, (f) plans to use CWPT in the future, (g) learning differences between students using CWPT and students using independent practice, (h) social benefits of CWPT, and (i) their overall evaluation of CWPT.

Positive aspects. Teacher comments indicate that they generally think that students enjoy using CWPT. One teacher commented that CWPT provided student-to-student interaction and that this influenced students to help others. Additionally, this teacher stated that she thought CWPT influenced students who usually did not interact with other students to begin interacting with others. Another teacher stated, "Students have such a happy feeling their eyes light up. They show that they are learning and they look so happy and satisfied when they see they can do it." Still another teacher stated that she believed that CWPT gives students freedom to communicate and that this is good for students in middle school.

Negative aspects. Two teachers stated that the most negative aspect of CWPT was that implementing it was physically exhausting. One teacher said that with CWPT "you don't get two seconds break" and that "you have to be on top of it all of the time." The second teacher commented that "CWPT takes a lot of energy." A third teacher expressed concern that CWPT might slow down the brighter students. She

suggested that additional homework or projects be assigned to challenge these students more. This teacher also stated that word problems took longer for students to work through and that this pressed the class for time when word problems were being solved. The fourth teacher responded that the negative aspects he experienced were related to his lack of preparation each day. One teacher complained that CWPT was "noisy."

Implementation requirements. The major complaint of teachers is that the score-reporting procedures were too difficult to implement effectively. One teacher commented that "it was hard to work with the points" and that doing independent practice was "easier on me." Another teacher stated that she dropped the score reporting, and that after she did this, she had no problems implementing CWPT. A third teacher said that he got lost trying to implement the score-reporting procedure, although he admitted that he did not really study how to do it. This teacher also said that students lied about their scores when they did report them. Monitoring students was also a complaint of this teacher because of the large number of things that teacher has to do during each period in middle school (e.g., writing passes, intercom announcement interruptions, student requests to go to the bathroom). This teacher stated that he had problems with discipline but stated this may be because "I was unorganized." He recommended an additional day of training.

The fourth teacher's comments differed from the other three in that she stated she had very little difficulty implementing CWPT. Although she stated that "she did not have enough time to do all you suggested," she commented that the monitoring was very easy but that "you just have to be organized." She said that "putting CWPT into practice was not difficult." It should be noted that during observations, this teacher was the most organized teacher of the four teachers in the study and appeared very confident. She stated that student training time should be extended. This teacher also questioned the value of points saying, "I don't think that it is a part of the effectiveness of the students learning." She commented that student motivation resulted from their desire to "work with other students" and their realization that they "were learning and making progress."

Teacher friendliness. This term refers to the degree to which teachers find CWPT usable in the classroom. One teacher stated that CWPT's use ability depends on the type of skill being learned. She stated that implementing CWPT to teach basic skills would be easier than implementing it to teach higher order thinking skills such as are required in applied math. She believes applied math is "not geared to CWPT." This teacher also commented that implementing CWPT with higher order thinking skills "would require a lot of teacher time to prepare." A second teacher stated that CWPT should be implemented as a unit and "should not be used all

the time." A third teacher said that CWPT has "tremendous potential." He also stated, "When peer pressure is functioning, it (CWPT) is teacher friendly." A fourth teacher commented that CWPT was "usable for a teacher who doesn't expect a classroom to be completely quiet."

CWPT's effectiveness in helping students learn problem-solving skills. Teachers all agreed that CWPT was helpful in teaching students to learn algebra problem solving, but they were not certain to what degree CWPT was a learning factor. One teacher expressed confusion as to whether student learning was a result of CWPT or because of the components of the algebra curriculum itself. Two teachers believed that CWPT was more effective for lower-performing students. One teacher stated that "I thought it did a lot more good for the low performing students than the high performing students." The other teacher said that "lower level kids felt a great deal of accomplishment" but that "higher level kids got frustrated." Overall, though, this teacher stated that she thought the high-level and the average-level students learned as well as the lower-level students. One teacher commented that all the students learned "most definitely" and that "overall, everyone improved." A fourth teacher said she thought learning "was more enjoyable for students using CWPT." This teacher added, "I look at the students who really struggled before and see how much better they did; it really makes you wonder." This teacher also stated that she

believed learning was occurring for the coach as well as the player.

Opinions regarding their use of CWPT in the future.

Teachers unanimously agreed that they would use CWPT in the future but only as one strategy within their entire teaching methodology. One teacher stated that "CWPT is a viable teaching tool, but I wouldn't want to use it all of the time." This teacher again commented that her energy level has to remain high for CWPT and that she could not sustain this energy level for a long time. Another teacher stated that he would use "parts of it, but I don't think I would use the whole thing--not for 5 weeks." A third teacher suggested that if teachers in preceding grades used it also, then perhaps students would be more accustomed to using CWPT and that this familiarity would make implementation easier. The fourth teacher stated, "I would like to incorporate CWPT into my class with other units."

Learning differences between students using CWPT and students using independent practice. One teacher stated that she did not think there was any difference between groups. A second teacher thought that CWPT "did a lot more good for the low-performing students than the high-performing students." Another teacher reflected that she saw "bright eyes" with the students using CWPT. She interpreted this as students being "impressed with themselves." She continued by saying, "I didn't see independent practice doing this because students

were working independently." This teacher commented that she thought the lower stanine students benefited from CWPT, adding "it helped being in a diverse group--they were able to tutor more effectively."

Social benefits. Teachers generally said that they thought CWPT had only minimal effects on students improving their social skills. One teacher commented that she did not observe any improvement overall, but she did see increased cooperation between student pairs while using CWPT. Another teacher stated that student social behavior improved "a little bit, but some students just absolutely didn't want to work with other students." A third teacher commented that she believed that students improved their general social interaction skills, but she did not list any specific skills. The fourth teacher commented that the attitude of one student in particular toward class in general became more positive and that this student increased his level of socialization with peers.

The comments of teachers indicate a general acceptance of CWPT, particularly in its effectiveness with low-performing students. Teachers maintain that students enjoyed using CWPT. Several teachers found CWPT very strenuous to implement on a daily basis because they were on their feet the entire period, and they were required to be constantly attentive to student behavior and questions. Teachers were very dissatisfied with the score-reporting procedures

involved with CWPT. Additional comments were made regarding the need to challenge high-performing students more. The need for more challenging material is more a factor of the particular algebra curriculum being used rather than a factor with CWPT. The lack of enough time in a class period for implementing CWPT with higher order thinking skills such as word problem solving is also a concern of the teachers. Teachers generally agree that they will use CWPT again, but three of the four teachers said they will use it in a less comprehensive form, such as for review or as a supplemental form of instruction and practice. Teachers responded that the social benefits using CWPT are only minimal.

CHAPTER V DISCUSSION

A discussion of the findings of the present investigation and implications for classwide peer tutoring and teaching higher order thinking math skills in diverse classrooms is presented. This chapter begins with a summary of the hypotheses. A discussion of the theoretical implications of the research findings, implications of the research findings to effective teaching principles, implications of the research findings to current CWPT literature, limitations of the study, and suggestions for future research are presented.

Summary of the Hypotheses

The general question of the study was as follows: Do general math students in middle school learn to solve higher order thinking math skills better with CWPT or independent practice? The following null hypotheses were posited for testing at the .05 level of confidence:

H1: There will be no statistically significant difference in performance on algebra problem-solving skills (from pretest to posttest) between treatment groups (CWPT & independent practice).

No significant differences in the performance of students in the CWPT and independent practice groups resulted

from pretest to posttest, resulting in a failure to reject the null hypothesis. It should be noted that significant differences were found between pretest and posttest for all students regardless of treatment group. Therefore, students in both treatment groups scored significantly higher on the posttest than on the pretest. Instruction and practice were equally beneficial to both groups of students.

H2: There will be no statistically significant difference in performance on algebra problem solving (from posttest to maintenance test) between treatment groups (CWPT & independent practice).

No significant differences in the performance between students in the CWPT and independent practice groups resulted from posttest to maintenance test, resulting in a failure to reject the null hypothesis. In addition, no significant differences between posttest and maintenance test are found for students in both treatment groups. Therefore, students maintained their level of performance from posttest to maintenance test regardless of treatment group, showing that students retained what they learned after 1 week of no algebra instruction.

H3: There will be no significant difference in performance on algebra problem solving from pretest to posttest between the at-risk group and the not-at-risk group.

No significant differences from pretest to posttest are found between the performance of students classified at risk of math failure and the performance of students classified not at risk of math failure, resulting in a failure to reject the null hypothesis. Significant differences are found between pretest and posttest for students in each classification group; that is, both students at risk of math failure and students not at risk of math failure increased their algebra problem-solving skills significantly over the instructional period. It should be noted that students at risk of math failure scored significantly lower on pretest compared to students not at risk of math failure, and this trend is also true for their performances on the posttest. However, the number of additional items each group of students responded correctly to on the posttest was statistically insignificant. Therefore, students in both groups received relatively equal benefit from instruction.

H4: There will be no statistically significant differences in performance on algebra problem solving from posttest to maintenance test between the at-risk group and the not-at-risk group.

No significant differences in performance are found between at-risk groups from posttest to maintenance test. Therefore, students in both groups performed equally as well from posttest to maintenance test. In addition, no significant differences are found between posttest and

maintenance test for both groups indicating that students in both groups retained what they learned after 1 week without algebra instruction.

H5: There will be no statistically significant differences in performance on algebra problem solving from pretest to posttest among four groups (CWPT/at risk, CWPT/not at risk, Independent Practice/at risk, Independent Practice/not at risk) as determined by the interaction between treatment group and at-risk classification.

No significant interaction effects are found in performance from pretest to posttest between treatment group and at-risk classification; that is, the significant improvement in performance of students from pretest to posttest is not a factor of either treatment group, at-risk classification, or any combination of the two variables.

H6: There will be no statistically significant differences in retention (from posttest to maintenance test) of algebra problem solving between the four groups (CWPT/at risk, CWPT/not at risk, Independent practice/at risk, Independent practice/not at risk) as determined by the interaction between treatment group and at-risk classification.

No significant interaction effects are found in performance from posttest to maintenance test between treatment group and at-risk classification; that is,

performance of students from posttest to maintenance test is not a factor of treatment group, at-risk classification, or any combination of the two variables.

Conclusions from Hypotheses Results

Students in both treatment groups and in both at-risk classifications benefited from the algebra instruction. Type of practice (CWPT or independent practice) was not a factor in their increased performance from pretest to posttest. Although the students classified at risk generally scored lower than students classified not at risk on pretest and posttest, their relative increases in achievement were equal.

Students in both treatment groups and in both at-risk classifications retained the skills they learned after 1 week of no algebra instruction. This finding suggests that students are capable of remembering the skills they learned from this particular type of algebra instruction, at least for a 1-week period of time.

In addition to these findings, there was no interaction effect between treatment group and at-risk classification. No combination of treatment group and at-risk classification affected the performance of students.

Overall, these findings suggest that the algebra instruction provided by Solving Division Equations: An Algebra Program for Students with Learning Problems was effective with both types of student practice, CWPT and independent practice. While neither type of student practice

was superior to the other in this study, it is significant that CWPT was effective in helping students learn higher order math thinking skills. This finding demonstrates that the uses of CWPT may be expanded from primary use with teaching basic academic skills. While CWPT has been used successfully to teach students reading comprehension skills with the Peabody Classwide Peer Tutoring system, this study marks the first attempt to use CWPT to teach higher order thinking skills in math.

Summary of Related Findings

Differences by Demographic and Ability Characteristics

Several of the related findings indicate differences in performance based on demographic and ability characteristics. Overall, the at-risk group scored significantly lower on pretest, posttest, and maintenance test than the not-at-risk group, but the at-risk group showed greater achievement (not statistically significant) than the not-at-risk group from pretest to posttest. This finding indicates that the algebra instruction (with CWPT and with independent practice) was more effective for the at-risk students. This conclusion may not be totally accurate. First, the average achievement from pretest to posttest for the at-risk group is 9.61 items while the average achievement for the not-at-risk group is 8.72, a difference of less than one item. In addition, the not-at-risk group had greater algebra problem-solving skills at pretest; therefore, they did not have as many skills to

learn. Their mean score at pretest was about 9.5 items correct out of 20 compared to the at-risk group mean score of 6 items correct out of 20. Their mean score at posttest was about 18 items correct out of 20. This is an accuracy rate of 90%. Because they started at pretest with more skills, they had a fewer number of skills to improve on. Moreover, a ceiling effect may be operating for the higher achieving students who constitute the not-at-risk group. Students who scored 20 out of 20 may have had higher scores if the number of test items was greater. The fact that the ceiling was 20 items may have kept the overall mean score of this group lower than it might have been otherwise.

Females and males in the at-risk group did not perform significantly different on the pretest, but females scored significantly lower on both the posttest and the maintenance test. These findings suggest that while males and females in the at-risk group showed similar algebra problem-solving skills before instruction, the females did not benefit from this instruction to the same degree males did. In contrast to these results, females in the not-at-risk group did score significantly lower than males on pretest, but no significant differences are found between females and males on posttest and maintenance test. These results suggest that the algebra curriculum is more effective for females not at risk of math failure than it is for females at risk of math failure. One explanation for this finding may be that, to begin with,

females not at risk of math failure have greater math skills than females at risk of math failure (8.72 items correct at pretest for females not at risk compared to 5.88 items correct for females at risk). If this is the case, then, not-at-risk females may be more likely to learn more advanced skills than females who have deficient skills initially.

A general trend in the data is that those students who scored lower on the pretest (at risk, minority, 14-15 years old, free lunch status) showed greater achievement from pretest to posttest. This trend indicates that the algebra instruction was more effective for students with fewer algebra problem-solving skills at the start. However, this conclusion cannot be reached with absolute confidence. As discussed previously, the achievement of higher performing students may be less than the lower performing students because of a ceiling effect operating due to the limited number of skills and items on the test.

No significant differences were found between treatment groups (CWPT & independent practice) for any of the demographic or ability characteristics measured except for the 14- to 15-year-old age group. The CWPT group scored significantly lower on the pretest than the independent practice group but scored higher on both the posttest and the maintenance test. This finding suggests that CWPT was more effective than independent practice for helping older students learn algebra problem-solving skills.

Differences by Skill Area

The finding that there are no significant differences between treatment groups (CWPT & independent practice) for the two skill areas (division equations & word problems) suggests that neither treatment was more effective than the other for learning division equations or word problems. Significant differences are found between at-risk groups for both skill areas on pretest, posttest, and maintenance test. The at-risk group scored lower than the not-at-risk group for both skill areas on all tests. These findings are consistent with the overall findings for total test scores.

Theoretical Implications of the Research Findings

Implications of these findings will now be related to the theoretical bases for the present study. The focus of this discussion will be on the theoretical principles of behavior theory and social learning theory and how they impacted classwide peer tutoring in the present study. Additionally, a discussion of how the principles of cooperative learning, which shares commonalities to both behavior learning theory and social learning theory, may have impacted this study will be presented.

Behavior Theory

Central to behavior learning theory are the principles of immediate reinforcement and group contingencies (Bolles, 1979; Bower, & Hilgard, 1981; Hulse, Egeth, & Deese, 1980). Both Edward Thorndike and B. F. Skinner supported the concept

of reinforcement (Bolles, 1979; Skinner, 1974). Most behavior theorists support the notion that learning is a result of a connection being developed between a stimulus and a response. Thorndike posited that learning occurs when a response is associated with a satisfying state of affairs (Bolles, 1979). Skinner is credited with the concept of operant conditioning in which responses followed closely by positive reinforcement becomes more likely to occur again. According to Skinner, all behavior is controlled by its consequences (Skinner, 1974).

Classwide peer tutoring uses immediate reinforcement because the coach awards points to the player after each of the player's correct responses. Because CWPT uses immediate and frequent reinforcement, it is logical to think that CWPT would be a superior form of practice than individual student practice. Although CWPT was an effective form of practice in this study, it was not superior to individual student practice. Students in the independent practice group received feedback from their teacher in the form of number of correct answers they had on their worksheets. However, this feedback was usually a day later and may or may not have been positive reinforcement since performance of individual students may have varied from day to day.

In this study, level of immediate reinforcement did not seem to be a factor since students in both treatment groups performed statistically the same on the posttest and

maintenance test. Therefore, the findings in this study do not support fully the theoretical principle of immediate reinforcement. It should be stressed that reinforcement in this study varied by degree of immediacy, not its presence or lack of presence, because students may have received reinforcement from improved scores on daily worksheets. Students in CWPT only received their reinforcement more frequently through receiving points for each problem solved correctly.

Another factor to consider is that CWPT procedures focus on extrinsic reinforcement through the awarding of points. Classwide peer tutoring does not control the amount of intrinsic reinforcement that individual students may employ while practicing to solve problems. Mercer (1992) identified intrinsic reinforcement as an important factor in the maintenance and retention of learned skills. Perhaps students in this study benefited from intrinsic forms of reinforcement to a greater extent than external reinforcement. The finding that all student groups retained the skills they learned and that overall average accuracy of performance was about 90% suggests that many students may have been operating at the maintenance stage of learning and, therefore, benefited more from intrinsic forms of reinforcement. No attempt was made to measure intrinsic reinforcement in this study so a definitive conclusion

regarding the effect of intrinsic reinforcement cannot be stated.

Group contingencies is another principle important to behavior learning theory (Bower & Hilgard, 1981). Basically, group contingencies refer to the tangible and social rewards received by individuals due to the performance of the group in which they are a member. Classwide peer tutoring employs group contingency reinforcement through the practice of awarding group recognition to the winning team at the end of each week of instruction. Students in the independent practice group did not receive any group recognition and so were not in a group contingency condition.

The fact that both treatment groups performed equally well on the posttest and maintenance test suggests that group contingency reinforcement was not a distinguishable factor in this study. However, because several teachers did not consistently total team points in the CWPT conditions (one teacher stopped totaling team points altogether), such a hypothesis is unfounded. There is the possibility that this lack of totaling team points by several teachers negated some of the learning affect of CWPT in this study.

Another possible explanation for the similarity in performance of treatment groups despite different degrees of immediate reinforcement and group reinforcement may be that student entry levels for learning the skill were differentiated enough to balance out any strong reinforcement

effect. As previously discussed, the stage of learning at which students enter for a particular skill may affect the importance of reinforcement for those students in learning that skill (Ayllon & Azrin, 1964; Smith & Lovitt, 1976). An analysis of pretest scores for all students in this study indicates a wide range of beginning skills (mean score of approximately 8 out of 20 correct, a standard deviation of approximately 5.00, and a range of 0 to 20). Because some students scored very low on the pretest and others scored quite high, the relative needs of students in regard to instruction were different. Students with fewer algebra problem-solving skills at pretest may have benefited more from the use of immediate and group reinforcement, while students with greater algebra problem-solving skills may have benefited less from such reinforcement. The possible differences in need for students at entry level may have sublimated any obvious reinforcement effect as determined by comparing posttest performance of the group with more reinforcement contingencies operating (CWPT) to the group with fewer reinforcement contingencies (independent practice).

Notwithstanding this possible differentiated effect of reinforcement, students at risk of math failure, who overall had low pretest scores, demonstrated slightly greater achievement from pretest to posttest than students not at risk of math failure (who had significantly higher pretest

scores). While the difference in achievement was not statistically significant, this small degree of greater achievement for at-risk students may indicate that reinforcement had more of an impact with them than with the higher performing not-at-risk students. In addition to this characteristic of the data, the fact that at-risk students generally had deficient skills but still performed as well or better than not-at-risk students suggests that greater learning was occurring for this group. This line of reasoning is plausible because the at-risk group's skills foundation for learning algebra problem-solving skills was weaker compared to the not-at-risk group.

Social Learning Theory

A primary tenet of social learning theory is Vygotsky's (1978) supposition that learning is mediated by social interaction, that learners internalize instruction through communication with others. Peer interaction is a primary variable in CWPT, and it is through this systematic interaction that students learn from each other as they practice academic skills. Student survey responses indicate that they liked the peer interaction and that they also believed that this interaction with their partner helped them learn to solve algebra division equations and algebra word problems. Teachers responded during interviews that this was an aspect of CWPT they liked and observed that students who before did not attempt math problems did attempt them with

CWPT. From the results of the posttests and maintenance tests, it is apparent that at-risk students did indeed learn problem-solving skills in the CWPT group.

Again, it must be noted that student performance in the CWPT group was equal to the performance of the students in the independent practice group, where there was no peer interaction during practice. Although students and teachers reported that they liked the peer interaction involved with CWPT, this interaction in itself was not a distinguishable factor in overall student performance.

Interestingly, another principle of social learning theory that may have been influential in this study is "zone of proximal development." Zone of proximal development can be described as a process in which the teacher (or coach) assumes the primary role of delivering instruction to the student (or player) but gradually removes instructional support as the student learns the skill being taught. Eventually, the teacher removes total support, and the student is capable of performing the skill independently. The student's zone of proximal development is small when he learns alone, but as he works with people, the student's zone of proximal development is expanded so that he takes on a self-regulatory and self-interrogative learning role (Vygotsky, 1978).

While students in CWPT were not trained to provide supported instruction in tutoring pairs, the algebra

curriculum prescribed this process during teacher instruction. Using scripts for guidance, teachers modeled the particular skill to be learned and then involved the students with a large amount of support through a guided practice phase in which the teacher and students worked problems together with teacher guidance. The last phase of instruction involved student practice in which the teacher offered support only when needed. Because this process was followed in both treatment conditions, it is possible that this was a powerful learning variable, perhaps more powerful than the type of student practice. If this was the case, the learning potential for students during the study's time period may have been satisfied by teacher instruction, and little learning potential was available to be affected by type of student practice.

Cooperative Learning

The principles of cooperative learning include facets of both learning theory and social learning theory. Slavin (1983) identified two key components of all cooperative learning methods. These components are also features of CWPT. The first component, cooperative task structures, are academic or social tasks students are allowed, encouraged, or required to work on together. The second component, cooperative learning structures, are used when two or more individuals are in a situation where the performance of one affects the degree to which the others are rewarded.

An important process of cooperative task structures is the learning that results from communication between students. Slavin (1983) identified social communication as crucial to cooperative learning. Vygotsky (1978) also identified communication of those in a group as an important aspect to social learning. Classwide peer tutoring incorporates this principle through the directed communication that occurs between tutoring partners. Although such social communication was clearly present during practice for the CWPT group, this communication was not present during independent practice. The presence of social communication, a key learning feature of social learning theory and cooperative learning theory, would suggest that the CWPT group would outperform the independent practice group. Because there is no difference in performance between the treatment groups, social communication did not appear to be a major learning factor in this study.

A possible explanation for this finding may be that the teacher instruction used in the algebra curriculum offered a form of social learning through the guided practice portion of the curriculum's instructional sequence. This supposition was discussed previously in relation to social learning theory's principle of zone of proximal development. Whereas that discussion focused on the instructional characteristic of fading teacher support in guided practice, the actual teacher-student communication that occurred with guided

practice may have facilitated social learning in this study. If this was the case, social learning during student practice may have been less of a crucial learning variable since social learning previously occurred during teacher instruction.

Cooperative learning theory shares with learning theory and CWPT the principle of group contingencies. Because the performance of the CWPT group in this study did not outperform the independent practice group, group contingencies did not appear to be a strong learning factor in this study. However, as was discussed previously, teachers did not consistently total team points. Because team points were not recorded consistently, student reward through winning team competitions did not occur consistently. This fact may have negated any appreciable group contingency learning effect in this study.

Relating the Present Findings to the Effective Instruction Literature

Five characteristics from the effective instruction literature that are incorporated into CWPT were presented in Chapter II. These characteristics include individualization, modeling, motivation, similarity, and high levels of academic engaged time (Berliner, 1988; Cohen, 1986; Greenwood, 1991a). Each characteristic will be discussed in relation to the present findings.

Individualization

Individualization occurs when instruction is provided that individually satisfies the learning needs of students. Classwide peer tutoring attempts to supply this need by pairing students together who work one-on-one and who provide the assistance that each student in the pair requires. While students were paired so that there was some difference in skill level between them, individual students' skill levels within pairs were similar enough that they could benefit from each other's instruction. Through informal observation by the researcher, students appeared to help each other satisfactorily. Very few requests for teacher help occurred during class observations. This would indicate that, overall, students were receiving satisfactory assistance from their partners. Also, when asked whether their partner helped them to solve problems they did not know, 70% of the students replied that their partner helped them "pretty well" or "very well." Twenty-three percent of the students responded that their partner did not help them at all. Although appropriate student help did not appear to occur all of the time, most students appear to have received adequate help.

A more crucial factor that seems to lessen the individuality of instruction in this study was the algebra curriculum itself. Because higher achieving students complained of not being challenged enough due to a slower

pace of instruction, the needs of these students did not appear to be met. The needs of many low achieving students did appear to be met since many made significant progress with the curriculum. This situation signifies a problem inherent in trying to apply one curriculum, that is, without level of difficulty options, to a diverse classroom of students. Some students benefit from the particular level of skill difficulty but others do not.

Modeling

All teachers modeled each skill to be learned during the "Describe and Model" stage that was scripted for each lesson. Teachers were observed to comply with this stage of instruction 100% during classroom observations. Also, all four teachers stated that they used each direct instruction step (advanced organizer, demonstrate and model, guided practice, and student practice) outlined in the curriculum for every lesson. Based on these data, it appears that modeling was consistently used by teachers in this study.

It cannot be determined how precisely or how well students modeled skills for their partners during CWPT. While implementation checklists show that students were checked off for modeling particular skills when appropriate, the quality of that modeling was not measured. Therefore, it is difficult to gauge the effect of modeling with the CWPT groups.

Motivation

Student questionnaire and teacher interview data appear to support the stance that students generally were motivated during the instruction. Eighty-five percent of the students responded in the questionnaire that they liked using CWPT "OK" or "a lot." Teachers also reported that most of the students liked working with partners. One teacher, who stopped totaling team points, stated that the students liked earning individual points and that the omission of team points did not affect their work at all. This teacher's observation supports the supposition that students were motivated even without consistently applied team competition.

Nonetheless, it must be stated that some students did not appear motivated, especially after some time had elapsed in the study. These students were primarily higher achieving students who complained to teachers about becoming bored with the program because they were not being challenged.

Similarity

Determining whether similarity was a learning factor in this study is difficult. If similarity was reflected only in CWPT because students were working with students, then it would have to be suggested that similarity did not affect learning very much for these students. No differences in performance between treatment groups supports this observation. However, if student reactions are considered, then similarity may have been more of a factor than the

quantitative results indicate. Eighty-two percent of the students surveyed responded that they liked working with a partner, and 86% of the students surveyed said they thought CWPT helped them learn to solve algebra problems. From this qualitative information, the similarity of students helping each other seemed to be important to students.

High Levels of Academic Engaged Time

The effect of high levels of academic engaged time is another characteristic that is hard to evaluate from the data in this study. A central tenet of CWPT is that it provides students with many opportunities to respond (Delquadri & Greenwood, 1981; Greenwood, Delquadri, & Hall, 1984). Increased opportunities for students to respond in an instructional period would increase levels of academic engaged time. Rate of opportunities for students to respond was not measured in this study, so conclusions regarding its effects can only be inferred through the data from CWPT implementation checklists and this researcher's informal observations. While two teachers were well organized and they directed CWPT very consistently (multiple implementation checks consistently ranged from 97%-100%), the two other teachers were less organized and did not direct CWPT very consistently (multiple implementation checks ranged from 39% to 94%). The differences in teacher implementation of CWPT make generalizations about high levels of academic engaged time for the whole student sample difficult. Interestingly,

though, student performance between teachers was very similar for both CWPT and independent practice groups. This situation would indicate that even if students using CWPT were more highly engaged academically than independent practice groups, this characteristic did not result in differential performance.

Implications of the Research Findings to the CWPT Literature

Three areas of CWPT research identified as in need of further investigation include (a) the effects of CWPT on learning higher order thinking skills, (b) the effects of CWPT on student learning in mainstream classes, and (c) the effects of CWPT with middle school students. This study attempted to address each of these research areas.

Higher Order Thinking Skills

The results of this study indicate that CWPT can be implemented successfully with teaching higher order thinking math skills. The CWPT group did not perform better than the independent practice group (both groups performed very similar), but both groups showed significant achievement on algebra problem solving from pretest to posttest. In addition to this, both groups showed retention of what they learned after 1 week of no instruction. These findings are important for several reasons. First, the potential uses of CWPT may be expanded from just basic academic skill work to academic work with higher order thinking skills. Certainly additional research should occur, but the results of this

study add to the work being done with Peabody Classwide Peer Tutoring and reading comprehension to create a stronger base for using CWPT with higher order thinking skills (Mathes et al., 1994). Second, the potential use of CWPT with higher order skills has implications for secondary education. A problem cited by some secondary educators is that the type of skills taught at this level become increasingly complex and state mandates create more and more instructional objectives that make including low performing students difficult (Schumm et al., 1995). Researchers investigating effective instructional strategies for secondary mainstream settings should address higher order thinking skills such as math problem solving.

Mainstream Classes

As students with learning problems become more included in general education classes, it is imperative that effective instructional strategies be verified with diverse classroom populations (Fuchs & Fuchs, 1994). This study investigated the effectiveness of CWPT in diverse general math classes. Some researchers advocate the use of CWPT as one set of effective instructional options for accommodating diverse learning styles and backgrounds (Maheady, Mallette, & Harper, 1991). While CWPT was not shown to be more effective than traditional independent student practice with higher order thinking skills, it was shown to be as effective as independent practice. At the very least, these findings

point to the potential use of CWPT as another teaching tool that teachers can use for teaching higher order thinking skills in diverse classrooms. Additional refinement of implementing CWPT with higher order thinking skills needs to occur to observe fully the potential of CWPT with higher order thinking skills in diverse classes.

It should be emphasized that both high performing students and low performing students showed significant academic achievement from pretest to posttest, findings which are congruent with previous CWPT research. However, several high achieving students expressed a need to be challenged with more complex skills than were available in the particular algebra curriculum used. Teachers also commented that high achieving students became frustrated because of this drawback to the curriculum. With respect to CWPT, these problems are not really relevant because these problems were a factor of the specific curriculum not the CWPT process itself. On the contrary, students' survey responses indicated that they liked using CWPT. Teachers also commented that students seemed to enjoy using CWPT.

Middle School Students

This study represents the first known attempt in the literature to study CWPT in strictly middle school settings. While much CWPT research has occurred in elementary settings and a small amount has occurred in high school settings, it is important that CWPT also be adapted to working with middle

school students. Middle school students using CWPT in this study showed significant academic achievement. In addition, these students responded that they liked using CWPT and they believe it helped them to learn algebra problem-solving skills.

An important consideration should be made with respect to using CWPT with middle school students. Are all procedures used in CWPT with elementary age students also appropriate for middle school age students? Team point totaling and team competition are CWPT procedures that might be of questionable value in this study. The fact that teachers did not implement team point totaling very consistently in this study negated potential learning effects of CWPT. However, student performance in these classes did not differ from classes that implemented team point totaling more consistently. If group contingencies and team competition were important learning variables for these middle school students, increased performance should be observed between classes with different levels of consistency in implementing team point totaling.

One possible explanation for this characteristic not being present in the data is that beginning middle school students may be less motivated by group contingencies than elementary age students or older middle school students and high school students. Most of the CWPT studies reviewed occur in elementary school settings. A few studies occurred

at the high school level. Peer influence and other peer factors become more important as students enter the middle school years. Younger middle school students may be struggling with how to handle this strong peer influence. Because they are less comfortable with dealing with their peers, they may be less able to work well under a group contingency plan. It is interesting to note that older middle school students (ages 14-15) using CWPT showed significant improvement compared to younger students (ages 12-13). This difference may be due to the older students' ability to deal with peer influence and so respond favorably to a group contingency plan. Elementary age students on average may not yet experience the intense peer influence that middle school students experience, and high school students may have worked through managing peer expectations and influences to a greater degree than their middle school counterparts. This is not to imply that high school students are immune to peer influence, but in relation to group contingency reinforcement, they may be more developmentally ready to manage it. This view leaves the middle school student "in the middle," struggling to deal with more intense peer influence and pressures. The older middle school students may have dealt with peer issues more successfully than the younger middle school students, and this may be the difference reflected in the posttest scores. This supposition is quite subjective at this point, and further

research into the role of group contingencies with middle school students should occur before evaluating the degree to which the supposition is correct or incorrect.

Considerations for Using CWPT with Higher Order Thinking Skills and with Middle School Students

Several points must be addressed concerning the implementation of CWPT with higher order thinking skills as well as using CWPT with middle school students. An important issue is the complexity of integrating CWPT with teaching higher order thinking skills. Teaching basic skills such as reading sight words, memorizing math facts, and spelling is a straightforward process with regard to the interaction that takes place between student pairs in CWPT. Usually the coach uses a prompt, such as a flash card, or reads words from a list, and the player responds to this prompt. Responses are either right or wrong without much ambiguity. Scoring is, therefore, a simple decision. Using higher order thinking skills does not follow such a straightforward format. By the very nature of higher order thinking skills, presenting prompts and scoring answers is less straightforward and the dialogue between coach and player is more involved than the dialogue between coach and player using basic skills. For example, students were taught how to prompt and answer algebra problems based on the type of skill that was involved. Separate model dialogues were developed to help students learn three different learning strategies taught in the algebra curriculum, to help students learn to solve

division equations, and to help students learn to solve word problems. Students were trained to use the correct dialogue with the particular skill being practiced. This training involved 5 class days.

In addition, problems were answered using multiple steps. Coaches had to make judgments as to whether particular player responses were correct or not dependent upon the steps the player used to solve particular problems. In other words, the prompt/answer process was much less straightforward than the process used with basic skills. This situation created a need for students to evaluate the degree of correctness for certain responses. Also, coaches had to be able to demonstrate how to solve multiple step problems when the player answered incorrectly. This situation placed much more burden on the coach as a "tutor" than would occur with basic academic skills.

Because of these factors, using CWPT with algebra problem-solving skills is a complex process. Expecting teachers to take on these developmental and training demands would be futile in most cases. In addition, the time needed to develop such complex CWPT procedures may hinder teachers from appropriately structuring their curriculum into forms suitable for tutoring (Greenwood, 1991b). Teachers in this study commented that this would be a major concern of theirs when contemplating whether they would use CWPT again to teach higher order thinking skills.

Using CWPT with middle school students may create a need to modify traditional CWPT procedures. A major concern of teachers was the score-reporting process. This is a common complaint of teachers when using CWPT (Maheady et al., 1988; Maheady, Harper, & Mallette, 1991). Three teachers cited the many interruptions and responsibilities they have at the middle school level as reasons the additional responsibility of totaling team points each day was overwhelming to them. Several teachers did not total points consistently for team scores during the study. One teacher stopped totaling points altogether about half way through the study. Teachers stated that when they did not total points, they did not see any difference in student performance or motivation from when they did total team points. This perception would indicate that group contingency reinforcement was not an important learning factor with these middle school students, a position that would be counter to previous research with CWPT. Caution is expressed in regard to this supposition. Teacher perception is very subjective, and more systematic research investigating CWPT with and without team points and team competition would need to occur to verify such a position.

It should be emphasized that students were still awarded individual points for responses in all classes during this study; therefore, individual reinforcement and immediate feedback did occur. The primary question with regard to group contingency reinforcement is whether it is less

necessary for middle-school-aged students than it is for elementary-aged students. Considering the negative views teachers in this study had with regard to score reporting and posting team scores and the negative effect this may have on teachers continuing to use CWPT, further research is warranted to determine the importance of using team points and competition with CWPT in middle school settings. Other researchers have also advocated additional research to determine the effectiveness of the individual procedures used in CWPT (Greenwood, Dinwiddie, Terry, et al., 1984; Maheady et al., 1988).

Limitations of the Present Study

The present study has several limitations. The limitations can be categorized into four general areas: (a) grade level of students, (b) the particular curriculum used, (c) population of students with disabilities, and (d) individual teacher styles.

Only eighth-grade students participated in the study. Systematic replication of the procedures is required with sixth- and seventh-grade students to generalize the findings to younger middle school students. Eighth-grade students were chosen for this study because, after reviewing the algebra curriculum with sixth-, seventh-, and eighth-grade teachers at the participating schools, only the eighth-grade teachers believed the range of skills addressed by the curriculum was appropriate for their students.

A second limitation of the study is the particular algebra curriculum that was used. Originally, this curriculum was developed for use with students who have learning problems. After using this curriculum in a pilot study with students with learning disabilities, it was apparent that the students did not learn to solve the word problems to mastery. In an attempt to ameliorate this deficiency, the number of lessons in the curriculum was expanded to present individual algebra problem-solving skills separately instead of combining several skills in one lesson.

While this adaptation seemed to aid the learning of the lower performing students in the study, the pace appeared to be too slow for the higher achieving students. Some students recommended that more challenging material be added to the curriculum, and all of the teachers expressed concern that their higher achieving students were not challenged enough and that some were frustrated and bored. This fact could have affected the participation of some students since their motivation may have been less than desired to maintain effectiveness as peer tutors. No quantitative data are available to confirm this observation, but student and teacher comments do support its possibility.

A third limitation of this study is the lack of students identified as having a disability. Only eight students identified with learning disabilities participated in the study. No other students were identified with a disability.

Two students were identified as speaking English as a second language. The number of students with disabilities is too small to draw any definitive conclusions regarding their achievement. However, the focus of the study was on students at risk of math failure which included all students who were currently functioning at a low performance level. Students with disabilities may or may not have been identified as at risk of math failure depending on their current level of math performance.

A fourth limitation of the study is the differing teaching styles of the participating teachers. Although attempts were made to standardize instruction (e.g., scripts to guide instruction, teachers were trained to follow precise procedures, the investigator consulted with teachers throughout the study to provide support to those who were having difficulty following through on particular teaching procedures), the experience of this investigator is that individual teachers have individual teaching styles that are difficult to change. Some teachers were more flexible in adapting their normal manner of instructional delivery and followed through with specific procedures more successfully than other teachers. While overall teacher implementation of the curriculum and CWPT was acceptable, teacher differences exist. The study's design controlled against differential teacher effects between treatment groups through stratifying

treatment conditions by teacher. Individual teachers taught the same number of CWPT and independent practice groups.

Summary of the Research Findings

Students in both treatment groups (CWPT & independent practice) made substantial gains in algebra problem solving from pretest to posttest and demonstrated retention of skills after 1 week of no algebra instruction. No significant differences in achievement are found between treatment groups. The exception to this trend are the 14- to 15-year-old students who performed better with CWPT than independent practice.

Students at risk of math failure scored consistently lower than students not at risk of math failure on pretest, posttest, and maintenance test regardless of treatment group. However, their relative achievement from pretest to posttest was equal. This finding suggests that while students at risk of math failure did not perform as well as students not at risk of math failure, they showed similar levels of learning. Both the at-risk group and the not-at-risk group demonstrated 1-week retention of skills.

Within the at-risk group, female students scored significantly lower on posttest and maintenance test than males. Their level of achievement from pretest to posttest is also lower than the at-risk males. The opposite results are present for the not-at-risk group. In this group, females began with lower pretest scores than males but scored

slightly higher than males on posttest. Female achievement from pretest to posttest was greater than the achievement of males.

No significant differences are found between treatment groups (CWPT & independent practice) on performance in the subskill areas of division equations and word problems. Significant differences are found between at-risk groups where students at risk scored significantly lower on both division equations and word problems for pretest, posttest, and maintenance test. However, achievement from pretest to posttest for the at-risk group is slightly greater than achievement from pretest to posttest for the not-at-risk group.

Student responses on questionnaires indicate that students enjoyed using CWPT and believed that it helped them to learn algebra problem-solving skills. Students suggested including more challenging skills for higher achieving students in the algebra curriculum. Teacher statements during interviews indicate that teachers generally liked CWPT and thought that it was especially helpful for low performing students. Several teachers stated that using CWPT was physically exhausting and that this experience would affect their decision to use CWPT again. All teachers disliked the score reporting procedure. Overall, teachers stated that they would probably use CWPT but only in a limited fashion, such as for review. One teacher indicated that she hoped to

use CWPT for other class units. Teachers expressed concern that their higher performing students were not challenged and that additional skills should be presented in the algebra curriculum that would create a stronger learning experience for these students. Interestingly, teacher concerns seemed to center more on the high achieving students' needs rather than on the substantial success of their low performing students.

Suggestions for Future Research

Additional research is necessary to determine the degree to which CWPT can be successful in helping to teach middle school students higher order thinking skills. It is important that there be further investigation into how to adapt CWPT for use with higher order thinking skills. Specifically, it is necessary to reduce the preparation time for integrating CWPT with higher order thinking skills instruction. Teachers are not likely to implement CWPT if the effort in preparation and time for planning is as great as it was for this study (Maheady, Harper, & Mallette, 1991). Identifying variables that affect the likelihood of teachers using effective instructional strategies is a crucial research need.

Developing and verifying the effectiveness of instructional strategies in diverse classrooms is of critical importance as the inclusion of students with learning problems in the general education classroom continues. In

relation to this research, CWPT was demonstrated to be one effective instructional strategy for seven diverse general math classes. However, some problems exist with the algebra curriculum used. While all student groups demonstrated success in learning basic algebra problem-solving skills, qualitative differences were observed between low performing students and high performing students. Low performing students made substantial progress in learning basic algebra problem-solving skills, and from student and teacher comments, these students enjoyed the instruction and demonstrated an eagerness to learn. High performing students tended to be frustrated and bored at times because they were not being challenged by skills introduced in the curriculum. This situation will likely continue to occur as educators attempt to provide instruction in diverse classrooms with one curriculum. It is essential that curriculum be diversified enough to challenge students of different achievement levels. The challenge for researchers is to do this while maintaining the integrity of the curriculum (e.g., ensuring that the curriculum maintains effective instructional characteristics) and making the curriculum usable and practical for the teacher. If the curriculum or instructional strategy is not usable and practical, it will not be used by the teacher.

A third area of needed research for CWPT is to determine further the effectiveness of specific CWPT procedures. This area of research has been already suggested by other

researchers (i.e., Greenwood, Dinwiddie, Terry, et al., 1984; Maheady et al., 1988) but became a concern in this study, particularly with respect to score-reporting procedures. This is not a new concern; teachers have complained about scoring procedures in other CWPT studies (Maheady et al., 1988; Maheady, Harper, & Mallette, 1991). Some teachers in this study did not consistently total team points. Interestingly, they did not observe any differences in student performance or student motivation between times they used team points and times they did not use them. Comparing results by individual teachers' classes did not reveal any performance differences between teachers who maintained team scoring and teachers who did not report maintaining team scoring. The following question arises from this observation. Do middle school students require slightly different CWPT procedures than elementary students? Because most of the previous CWPT research has focused on elementary age students and little if any at all has focused on middle school students, systematic procedures which have been successful for younger students may not be as successful for older students. Although the effectiveness of group contingency reinforcement has much theoretical and research support, perhaps individual reinforcement is most effective with middle school students. Such a situation might explain the results of this study. Investigating the effectiveness of individual procedures in CWPT should include examining

differences between different age groups (e.g., elementary, middle, and high school).

A fourth area for future research with CWPT is to investigate further its potential for older students who may have been retained a grade or who started school late. The results in this study which indicate that CWPT was more effective for the 14- and 15-year-old students warrant additional research to determine whether this effect occurs consistently. Perhaps CWPT could be a useful instructional strategy for classes which have a large number of older students who have been retained or who have shown previous academic difficulty. This could be helpful for drop-out-prevention programs or other at-risk directives.

A final area for future research is the effectiveness of CWPT for teaching higher order thinking skills to students with disabilities. There were not enough students with disabilities included in this study to reach conclusions about this population.

APPENDIX A
PRETEST

Pretest

- 1) $7a = 28$
- 2) $4c = 32$
- 3) $3y + 6y = 54$
- 4) $2r + 9r = 77$
- 5) $3d + 2 = 20$
- 6) $9x + 8 = 80$
- 7) $8s - 7 = 33$
- 8) $3t - 9 = 21$
- 9) $5m + 3m + 3 = 67$
- 10) $2p + 4p + 6 = 36$
- 11) $6g + 6g - 6 = 42$
- 12) $3i + 2i - 1 = 44$
- 13) $4b + 3b + 18 - 9 = 37$
- 14) $7f + 2f + 12 - 5 = 34$
- 15) Eric spent \$6 playing 3 video games at the arcade. If each game cost the same amount, how much did Eric spend on each game?
- 16) On their camping trip, Mark, Andy, and Ross gathered firewood in the morning. In the afternoon, Paul and Bob gathered more firewood. In the evening, they counted the pieces of firewood and discovered that each boy had found the same amount of firewood. If they had 30 pieces of firewood altogether, how many pieces did each boy find?

- 17) Lori is 20 years old. She is 3 times plus 2 years older than her younger sister, Ellen. How old is Ellen?
- 18) In ceramics class, Angela and Denise each made the same number of animal figures for the science exhibit. One figure was dropped and broken on the way to setting up the exhibit. If 19 figures were in the display, how many animal figures did each girl make in ceramics class?
- 19) The 4 students in Mr. Gomez's first period math class each completed the assigned page of algebra problems. During second period, 6 students completed the same page in their books. In addition, 1 student completed 4 geometry problems. If Mr. Gomez had a total of 74 problems to grade, how many algebra problems were completed by each student?
- 20) Penny likes to do word processing to earn extra money. She has a standard charge for business letters. She did 7 letters on Thursday and 4 letters on Friday. On Saturday, she had to spend \$4 on paper. If she still had \$106 after she bought the paper, what did she charge for each letter?

APPENDIX B
POSTTEST

Posttest

- 1) $6a = 24$
- 2) $5c = 30$
- 3) $2y + 5y = 49$
- 4) $3r + 6r = 72$
- 5) $3d + 8 = 38$
- 6) $7x + 8 = 43$
- 7) $9s - 6 = 48$
- 8) $4t - 7 = 21$
- 9) $6m + 2m + 9 = 57$
- 10) $2p + 3p + 5 = 40$
- 11) $5g + 5g - 8 = 52$
- 12) $2i + 4i - 2 = 16$
- 13) $3b + 5b + 14 - 7 = 63$
- 14) $6f + f + 11 - 7 = 67$
- 15) During their summer vacation, Sam's family bicycled 48 miles around Washington, DC on a sightseeing tour. They rode for 4 days and covered the same distance each day. How many miles did they ride each day?
- 16) At the school store, you can buy pencils with your name printed next to the name of the football team. Since Jim is always losing pencils, he decided to buy 6 pencils. His best friend, Bobby, bought 3 pencils with his name on them. Together they spent \$0.81. What was the cost of each pencil?

- 17) Ms. Garcia, the biology teacher, had 9 notebooks full of science experiments to grade. There were 73 experiments including 10 that should have been turned in to the chemistry teacher. If each notebook contained the same number of biology experiments, how many biology experiments were in each notebook?
- 18) Nine students from Ms. Anderson's room each earned the same number of points in the school homework contest. Unfortunately, 5 points were lost by Mrs. Anderson's room for a late paper. When the points were totaled, Ms. Anderson's room had 85 points. How many points did each of the 9 students earn before the penalty?
- 19) During the morning race, Matt and Phil ran the full length of the course. In the afternoon, Jerry, Juan, and Dwayne also ran the full length of the course. Tim hurt his ankle and only ran 5 miles. The combined number of miles for all runners was 40 miles. How long was the course?
- 20) Jerry has a paper route. Last week he collected payments on 3 afternoons. This week he collected payments on 4 afternoons. He collected the same amount each day. After he finished collecting, he had to send \$30 to the newspaper company. He had \$26 left to spend. How much did he collect each day?

APPENDIX C
MAINTENANCE TEST

Maintenance Test

1) $9b = 27$

2) $6c = 42$

3) $3x + 5x = 32$

4) $4r + 7r = 55$

5) $4v + 3 = 19$

6) $7p + 6 = 62$

7) $4m - 8 = 12$

8) $3s - 6 = 15$

9) $2n + 7n + 2 = 83$
31

10) $2y + 2y + 7 =$

11) $7d + 5d - 4 = 32$
37

12) $6i + 2i - 3 =$

13) $4w + 2w + 16 - 7 = 27$
 $6 = 36$

14) $4h + 3h + 14 -$

- 15) Dwayne spent \$8 playing 4 video games. If each game cost the same amount, how much did Dwayne spend on each game?

- 16) At the class pizza party, Raul, Jessi, and Shanequa each ate the same number of pepperoni pizza slices. Not to be outdone, Andy and Maria ate the same number of pepperoni pizza slices. Andy also ate 2 slices of cheese pizza. If all together they ate a total of 22 pizza slices, how many slices of pepperoni pizza did each student eat?

- 17) LuAnn is 31 years old. She is 4 times plus 3 years older than her nephew, Paul. How old is Paul?
- 18) In art class, Josh and Andrea each made the same number of paper mache animals for the nature exhibit. One figure was dropped on the floor and was accidentally stepped on as the students took the figures to the library for display. If 15 undamaged figures were in the display, how many paper mache figures did each student make in art class?
- 19) At the grocery store, James bought 4 candy bars. Demetri especially liked these type candy bars and bought 6 for himself. All together, the two boys spent \$4 on the candy bars. How much did each candy bar cost?
- 20) Christal baby-sits for several of her neighbors. Last month, she collected payments from 2 different neighbors. This month, she collected payments from 4 neighbors. She spent \$5 on supplies she used to make fliers for advertising her services in the neighborhood. She had \$31 at the end of the two months. How much did she make each time she baby-sat?

APPENDIX D
CWPT IMPLEMENTATION CHECKLIST

Solving Division Equations with Classwide Peer Tutoring

Fidelity of Treatment Record

Teacher: _____ Date: _____

School: _____ Observer: _____

Time of 1st Command: _____

Time of last Command: _____

Scoring Code: + Behavior demonstrated
- Behavior not observed
NA Not applicable

TEACHER IMPLEMENTATION

Organization and Setup

- _____ 1. Teacher announces, "It's time for Classwide Peer Tutoring" and students get out their materials.
- _____ 2. Students move, if necessary, and get materials ready (i.e., set up desk, turn to correct tutoring sheet) within 2 minutes of the first command.
- _____ 3. Tutoring rules, team assignments, and score board are posted somewhere in the room.

General Implementation

- _____ 1. Teacher passes out tutoring sheets and gives directions as appropriate.
- _____ 2. Teacher implements classwide peer tutoring for at least 10 minutes for each role segment.
- _____ 3. Teacher's transitions between activities are relatively quick (about 20 to 30 seconds). Teacher appears calm.

Monitoring and Motivation

- _____ 1. Teacher moves around classroom and is watchful during a majority (at least 75%) of the tutoring session.
- _____ 2. Teacher provides corrective feedback as needed.
- _____ 3. Teacher responds to HELP signs in a timely and consistent manner.
- _____ 4. Teacher verbally praises and /or gives bonus points to individuals, pairs or the whole class for desired tutoring/reading behaviors.
- _____ 5. Bonus points are given out only for tutoring or problem solving related behaviors.
- _____ 6. Teacher is generally positive, upbeat, and energetic about tutoring.

What to improve:

STUDENT IMPLEMENTATION

Directions: Choose 1 dyad and answer all questions under this heading with respect to this dyad.

General

- _____ 1. Students set-up materials correctly and quickly.
- _____ 2. Students begin classwide peer tutoring promptly following the teacher's command.
- _____ 3. Students work cooperatively together. There is no arguing or complaining.
- _____ 4. Points are recorded quickly and accurately.

(First tutoring period)

1st Coach

- _____ 1. Coach reads problems or asks questions clearly and audibly.
- _____ 2. Coach listens and follows along as the player solves the problems or answers the questions.
- _____ 3. Coach awards 2 points after each problem is solved or question is answered correctly the first time.
- _____ 4. Coach reliably identifies incorrect responses.
- _____ 5. Coach gives answer and attempts to show the player how to solve problems (when appropriate) when the player responds incorrectly.
- _____ 6. Coach awards 1 point after the player solves the problem or answers the question correctly on the second attempt.
- _____ 7. Coach raises **HELP** card when needed.

1st Player

- _____ 1. Player solves problems or answers questions in a timely manner (begins to solve problem in 20 to 30 seconds).
- _____ 2. Player says answer clearly and with appropriate volume.

- _____ 3. Player attempts to solve problems or answer questions a second time after an incorrect response.
- _____ 4. Player listens to coach attentively as he/she gives instructions, gives an answer, or describes how to solve problems.

(Second tutoring period)

2nd Coach

- _____ 1. Coach reads problems or asks questions clearly and audibly.
- _____ 2. Coach listens and follows along as the player solves the problems or answers the questions.
- _____ 3. Coach awards 2 points after each problem is solved or question is answered correctly the first time.
- _____ 4. Coach reliably identifies incorrect responses.
- _____ 5. Coach gives answer and attempts to show the player how to solve problems (when appropriate) when the player responds incorrectly.
- _____ 6. Coach awards 1 point after the player solves the problem or answers the question correctly on the second attempt.
- _____ 7. Coach raises **HELP** card when needed.

2nd Player

- _____ 1. Player solves problems or answers questions in a timely manner (begins to solve problem in 20 to 30 seconds).
- _____ 2. Player says answer clearly and with appropriate volume.
- _____ 3. Player attempts to solve problems or answer questions a second time after an incorrect response.
- _____ 4. Player listens to coach attentively as he/she gives instructions, gives an answer, or describes how to solve problems.

CWPT Implementation Scoring Sheet

Teacher: _____ Period: _____
 Date: _____

Teacher Implementation

of + = _____
 _____ = _____ %

12 - NA = _____

Student Implementation
General

of + = _____
 _____ = _____ %

4 - NA = _____

Coach Behavior

of + = _____
 _____ = _____ %

22 - NA = _____

Player Behavior

of + = _____
 _____ = _____ %

8 - NA = _____

Total Student Score

of + = _____
 _____ = _____ %

34 - NA = _____

Total Integrity Score

Total of + = _____
 _____ = _____ %

46 - NA = _____

APPENDIX E
PEER TUTORING
STUDENT EVALUATION INVENTORY

Classwide Peer Tutoring Student Survey

Directions: Circle the answer that best describes what you think.

1. If you were a teacher, would you let your students use classwide peer tutoring?
1-definitely not 2-maybe 3-definitely would
2. Would classwide peer tutoring be OK to use with students in other classes?
1-not at all 2-maybe 3-yes
3. How fair is classwide peer tutoring?
1-very unfair 2-unfair 3-not unfair
4. Does classwide peer tutoring seem like something that should be done?
1-not at all 2-maybe it should be done 3-definitely it should be done
5. Do you think classwide peer tutoring treats students nicely?
1-not nice at all 2-kind of nice 3-treats them very nicely
6. Do you think classwide peer tutoring could be harmful to students?
1-very harmful 2-harmful 3-not harmful at all
7. How much do you like the things you did using classwide peer tutoring?
1-do not like them very much 2-they're OK 3-like them very much
8. How much did classwide peer tutoring help you learn to solve division equations?
1-not at all 2-pretty well 3-very well
9. How much did classwide peer tutoring help you to learn to solve algebra word problems?
1-not at all 2-pretty well 3-very well

10. How much do you like the use of teams?
- | | | |
|----------------------------|-------------------------|------------------------|
| 1-do not like it
at all | 2-moderately like
it | 3-like it very
much |
|----------------------------|-------------------------|------------------------|
11. How much do you like earning points during classwide tutoring?
- | | | |
|----------------------------|-------------------------|------------------------|
| 1-do not like
it at all | 2-moderately
like it | 3-like it very
much |
|----------------------------|-------------------------|------------------------|
12. How much do you like working with a partner?
- | | | |
|----------------------------|--------------------|------------------------|
| 1-do not like
it at all | 2-moderately
it | 3-like it very
much |
|----------------------------|--------------------|------------------------|
13. Did your partner help you when you did not know how to solve a problem?
- | | | |
|--------------|---------------|-------------|
| 1-not at all | 2-pretty well | 3-very well |
|--------------|---------------|-------------|
14. How much did classwide peer tutoring help you become better friends with other students?
- | | | |
|--------------|--------|---------|
| 1-not at all | 2-some | 3-a lot |
|--------------|--------|---------|
15. Do you think people were more friendly to you after you began classwide peer tutoring?
- | | | |
|--------------|--------|---------|
| 1-not at all | 2-some | 3-a lot |
|--------------|--------|---------|
16. Do you think people were more friendly to other students after you began classwide peer tutoring?
- | | | |
|--------------|--------|---------|
| 1-not at all | 2-some | 3-a lot |
|--------------|--------|---------|
17. Do you think some other students liked you better after you began classwide peer tutoring?
- | | | |
|--------------|--------|---------|
| 1-not at all | 2-some | 3-a lot |
|--------------|--------|---------|
18. Do you think some students think you are smarter now, than before classwide peer tutoring?
- | | | |
|--------------|--------|---------|
| 1-not at all | 2-some | 3-a lot |
|--------------|--------|---------|
19. Overall, what do you think of classwide peer tutoring?
- | | | |
|---------------------------|------|-----------------|
| 1-don't like
it at all | 2-OK | 3-like it a lot |
|---------------------------|------|-----------------|

APPENDIX F
CWPT INFORMAL
TEACHER INTERVIEW QUESTIONS

1. What is your overall opinion about classwide peer tutoring as an aide for instructing students in a diverse classroom?
2. What are CWPT's positive aspects?
3. What are CWPT's negative aspects?
4. Were the implementation requirements for using CWPT reasonable (preparation of materials, scoring, maintaining discipline, monitoring student pairs)?
5. Were the time requirements for training students to use CWPT reasonable (Why or Why not)?
6. Do you think that CWPT is teacher friendly (is it usable in the classroom for day to day instruction)?
7. Do you think CWPT helped your students learn?
8. Did you notice any differences in results between low performing students, average performing students, and high performing students (socially as well as academically)?
9. Will you use CWPT to assist your instruction in the future? Why? Why not?
10. What learning differences did you observe between your CWPT classes and your independent practice classes?
11. Did you observe any improvement in social interaction skills between students while using CWPT?
12. With which types of students did you think CWPT was most helpful?

APPENDIX G
ALGEBRA CURRICULUM LESSON

Solving Division Equations Using the "DRAW" Strategy

GOALS

- To introduce the students to the concept of solving division equations that require the combining of terms that include the variables (e.g., $3y + 2y = 15$).
- To reinforce students' memories of "DRAW," a learning strategy that can be used to solve division equations when students do not know the answers from memory.
- To ensure that students can name each step of the "DRAW" Strategy.
- To ensure that the students know three ways multiplication shown in algebra equations [i.e., $3y$, $3 \cdot y$, $3(y)$].

MATERIALS

- Chalkboard and chalk
- *The "DRAW" Strategy Sheet*, one per student
- *Learning Sheet 5*, one per student
- *The "DRAW" Strategy Rules Sheet*, one per student
- A poster or overhead transparency of the "DRAW" Strategy (optional)
- Overhead projector and screen (optional)
- Blank paper (optional)

GIVE AN ADVANCED ORGANIZER

1. **Tell the students what they will be doing and why.**

Sample dialogue:

In the last lesson, we learned about a strategy to help us solve division equations using circles and lines. Who can tell me what this strategy is called? (Elicit the response, "DRAW.") That's correct. (Ask various students to name

the different steps of the "DRAW" strategy. Ask them to say each letter of "DRAW" and recite each step. Today, we will continue to learn about using draw to solve division equations. When we're uncertain of an answer and don't have objects available, "DRAW" helps us find the answer.

What are we going to do today? (Elicit the response, "Learn a strategy to help us solve equations when we don't have objects and don't know the answer.")

DESCRIBE AND MODEL

1. Instruct the students to compute Problem 2, $4b + 2b = 24$.

Sample dialogue:

Let's do Problem 2, $4b + 2b = 24$, together using "DRAW". What does the "D" in "DRAW" tell us to do? (Elicit the response, "Discover the variable, the operations, and what the left side of the equation equals.") What is the variable? (Elicit the response, "b.") What is the operation? (Elicit the response, "Add $4b$ and $2b$ ") What do all the b variables equal? (Elicit the response, " 24 ." Have we completed Step 1 of "DRAW?" (Elicit the response, "Yes." Point out that each procedure in Step 1 has been completed.)

What does the "R" in "DRAW" tell us to do? (Elicit the response, "Read the equation, and combine like terms on each side of the equation.") What like terms in the problem, $4b + 2b = 24$, can be combined? (Elicit the response, " $4b$ and $2b$." Yes. The terms $4b$ and $2b$ can be combined by adding them. When we add $4b$ and $2b$, what do we get? (Elicit the response, " $6b$." Since no other terms need to be combined, we can rewrite the equation. How would we rewrite it? (Elicit the response, " $6b = 24$," and write it on the chalkboard.)

Now, what does Step 3 or the "A" in "DRAW" tell us to do? (Elicit the response, "Answer the equation, or draw and check.") Let's assume that we do not know the answer and need to draw the equation. What does $6b$ tell us to draw? (Elicit the response, "Six circles.") That correct. We will draw a circle for each of the b s. You draw six circles on your paper while I draw them on the chalkboard. (Check to see that each student draws six circles.) What does $6b$

mean? (Elicit the response, "Multiply, or six groups of b .") Since $6b$ means six circles of b and the equation says that $6b$ equals 24. We have not yet learned how to draw numbers, so let's review the DRAW Strategy Rules Sheet to find out how to draw the number 24 in $6b=24$. (Refer to the DRAW Strategy Rules Sheet and review Rules numbers 2-4. Be sure students understand these rules before proceeding.) Now, how do we draw the number 24? (Elicit the response, "Divide twenty-four tallies equally among the circles.") Yes. We keep drawing tallies in each circle until twenty-four tallies have been drawn. You draw tallies on your Learning Sheet while I draw them on the chalkboard. (Check to see that each student draws four tallies in each circle.) Now let's check our drawing. Did you draw six circles? (Pause while students check their drawing.) Did you draw twenty-four tallies. (Pause while students check their drawing.) Did you draw the same number of tallies in each circle? (Pause while students check their drawing.)

Finally, what does Step 4 or the "W" in "DRAW" tell us to do? (Elicit the response, "Write the answer for the variable, and check the equation.") Yes. First we write the answer. How do we determine what b equals? (Elicit the response, "Count the number of tallies that are in each circle.") What does b equal? (Elicit the response, "4.") Yes. It is 4 because four tallies are in each circle. Everybody write " $b = 4$ " under Problem 2 on your Learning Sheet. Next, we need to check the equation. How do we check the equation? (Elicit the response, "Replace the b with 4 and multiply to see if the equation is correct.") Now, check the equation below Problem 2 while I do it on the chalkboard. [Write " $6(4) = 24$ " on the chalkboard.] Does 6 times 4 equal 24? (Elicit the response, "Yes.") Yes, it does. So, b equals 4 is correct.

2. Demonstrate how to solve Problem 3 using the same procedure.

CONDUCT GUIDED PRACTICE

1. Guide the students through Problem 4 using the "DRAW" Strategy. Do not demonstrate the strategy yourself unless further demonstrations appear necessary.

Sample dialogue:

It's your turn to do Problem 4, $7f + f = 40$. Look at the equation and do what Step 1 or the "D" in "DRAW" tells you to do. (Pause while the students complete Step 1.) What is the variable? (Elicit the response, " f .") What is the operation? (Elicit the response, "Add $7f$ and f .") What do the variables on the left side of the equation equal? (Elicit the response, " 40 .")

Now do Step 2 in "DRAW." (Pause while the students work.) What is the equation? (Elicit the response, " $7f + f = 40$.") What like terms need to be combined? (Elicit the response, " $7f$ and f .") Yes. The variables need to be added together. Combine $7f$ and f and rewrite the equation under Problem 4. (Pause while the students work.) What is the new equation? (Elicit the response, " $8f$ equals 40 .") Good thinking! It is $8f$ equals 40 . (Check to see that the students write it correctly.) What does $8f$ mean? (Elicit the response, "Eight times f or eight groups of f .") Now do what Step 3 in "DRAW" tells you to do. Pretend you do not know the answer and do the drawing. (Pause for the students to work.) What did you draw for $8f$? (Elicit the response, "Eight circles.") Right. How did you draw the 40 ? (Elicit the response, "By dividing forty tallies among the eight circles.") Check your drawing to see if it is correct. You should have eight circles, forty tallies, and the same number of tallies in each circle. (Pause while the students check their drawing.)

Finally, do what Step 4 in "DRAW" tells you to do. (Pause while the students work.) What is the value of f ? (Elicit the response, " 5 .") Great work. The value of f is 5 because there are five tallies in each circle. When you replace f with 5 in the equation, does it work? (Elicit the response, "Yes, because 8 times 5 equals 40 .") Good thinking. (Check to see that the students write " $f = 5$ " and " $8 \cdot 5 = 40$ " on their Learning Sheet.)

2. Guide the students through Problems 5 and 6. Do not ask for the answers, however, as these are the first problems to be scored on the Learning Sheet.

Sample dialogue:

Look at Problems 5 and 6. Use the steps in "DRAW" to solve the equations. You may use *The "DRAW" Strategy Sheet* to help you do the four steps. (Move among the

students, and assist those students who need help by giving them prompts and cues. Do not provide the answers because Problems 5 and 6 are scored on the Learning Sheet.)

CONDUCT INDEPENDENT PRACTICE

1. Instruct the students to solve Problems 7 through 14 independently or in their classwide peer tutoring pairs.

Sample dialogue:

Please do the rest of the problems on your Learning Sheet. Be sure to use "DRAW" for each problem. Draw circles and tallies for problems that you cannot solve in your head. When you get to Problems 13 and 14, fill in the blanks below each problem and use "DRAW" to solve the equations. What are you going to do? (Elicit the response, "Use 'DRAW' to do Problems 7 through 14 and fill in the blanks below the word problems.") That's correct. Now do Problems 7 through 14.

2. Circulate and monitor the students' work while they solve the problems.
3. Collect all papers when the students indicate that they are finished or record points from students using classwide peer tutoring.

PROVIDE FEEDBACK

1. Score the last 10 problems on each student's Learning Sheet (Problems 5-14) for correct and incorrect responses; determine the total percentage of correct responses.
2. Individually meet with each student; help the student plot his score on his *Division Equation Progress Chart*. Begin by making at least one specific, positive statement about the student's work. Compare the student's score to the mastery goal line, noting any progress.
3. Specify incorrect responses and corresponding error patterns if they exist. Explain where errors have occurred. Try to make these statements without using the word "you."

4. Show the student how to perform the task. For at least one problem missed, show the student how to compute the problem correctly by drawing circles and tallies. While demonstrating how to correctly compute a problem, verbalize how the student should "think" or talk to himself the next time he encounters a similar problem.

5. Ask the student to practice the application. Using a different problem, ask the student to show you how he will proceed in the future. Check to see that the student correctly draws the proper number of circles and tallies.

6. Close the feedback session. Make a positive statement about the student's performance in the feedback process and your expectations for the future.

Mastery

Each student should be able to name and explain the four steps of "DRAW" without looking at *The "DRAW" Strategy Sheet*. Also, each student should be able to explain the four "DRAW" rules without looking at *The "DRAW" Strategy Rule Sheet*. Although many students will be able to do this within this lesson, others may need additional practice. In such cases, have the students proceed with subsequent lessons yet practice naming and explaining the steps and rules daily until they are able to recite and explain the meaning of all the steps and rules. A good time to do this is in the daily advance organizer.

Helpful Hint

If the students need more space to draw circles and tallies, try one of these suggestions:

- Provide the students with blank paper for drawing circles and tallies.
- Allow the students to draw on the back of their Learning Sheet.
- Teach the students how to space circles and tallies by providing a model of correctly sized and spaced circles and tallies.

Helpful Hint

If the students count tallies incorrectly, try one of these suggestions:

- 🍏 Teach the students to leave adequate space between tallies.
- 🍏 Teach the students to touch each tally as they count.

REFERENCES

- The Association of Persons with Severe Handicaps. (1992, July). CEC slips back: ASCD steps forward. *TASH Newsletter*, 18(1).
- Ayllon, T., & Azrin, N. H. (1964). Reinforcement and instructions with mental patients. *Journal of Experimental Analysis of Behavior*, 7, 327-331.
- Barlow, D. H., Hayes, S. C., & Nelson, R. O. (1984). Clinical replication. In D. H. Barlow, R. O. Nelson, & S. C. Hayes (Eds.), *The scientist practitioner: Research and accountability in clinical and educational settings* (pp. 290-346). New York: Pergamon.
- Barry, N. J., Jr., & Overman, P. B. (1977). Comparison of the effectiveness of adult and peer models with educable mentally retarded children. *American Journal of Mental Deficiency*, 82, 33-36.
- Beirne-Smith, M. (1991). Peer tutoring in arithmetic for children with learning disabilities. *Exceptional Children*, 57, 330-337.
- Berliner, D. (1988). Peer tutoring: A new look at a popular practice. *Instructor*, 97(5), 14-15.
- Berliner, D. C., Fisher, C. W., Filby, N., & Marlieve, R. (1979). *Proposal for phase III of begining teacher evaluation study*. Berkley, CA: McCutchan.
- Bolles, R. C. (1979). *Learning theory* (2nd ed.). New York: Holt, Rinehart, and Wilson.
- Bower, G. H., & Hilgard, E. R. (1981). *Theories of learning* (5th ed.). Englewood Cliffs, NJ: Prentice Hall, Inc.
- Brofftenbrenner, U. (1970). *The two worlds of childhood: U. S. and the U. S. S. R.* New York: Russel Sage Foundation.
- Buckholdt, D. R., & Wodarski, J. S. (1978). The effects of different reinforcement systems on cooperative behaviors exhibited by children in classroom contexts. *Journal of Research and Development in Education*, 12, 50-60.

- Carpenter, R. L. (1985). Mathematics instruction in resource rooms: Instruction time and teacher competence. *Learning Disabilities Quarterly*, 8, 95-100.
- Carta, J. J., Greenwood, C. R., Dinwiddie, G., Kohler, F. W., & Delquadri, J. C. (1987). The Juniper Gardens classwide peer tutoring programs for spelling, math, and reading. Kansas City: University of Kansas, Bureau of Child Research, Juniper Gardens Children's Project.
- Cawley, J. F. (1985). Cognition and learning disabled. In J. F. Cawley (Ed.), *Cognitive strategies in mathematics for the learning disabled* (pp. 1-32). Rockville, MD: Aspen Systems Corporation.
- Cohen, J. (1986). Theoretical considerations of peer tutoring. *Psychology in the Schools*, 23, 175-186.
- Conway, R. N. F., & Gow, L. (1988). Mainstreaming special class students with mild handicaps through group instruction. *Remedial and Special Education*, 9(5), 34-41.
- Cook, S. B., Scruggs, T. E., Mastropieri, M. A., & Casto, G. C. (1985-86). Handicapped students as tutors. *The Journal of Special Education*, 19, 483-492.
- Delquadri, J., & Greenwood, C. R. (1981). *The importance of "opportunity to respond" in the education of the black minority student*. (ERIC Document Reproduction Service No. ED 204 893)
- Delquadri, J., Greenwood, C. R., Stretton, K., & Hall, R. V. (1983). The peer tutoring spelling game: A classroom procedure for increasing opportunity to respond and spelling performance. *Education and Treatment of Children*, 6, 225-239.
- Delquadri, J., Greenwood, C. R., Whorton, D., Carta, J. J., & Hall, R. V. (1986). Classwide peer tutoring. *Exceptional Children*, 52, 535-542.
- Deshler, D. D., Schumaker, J. B., & Lenz, B. K. (1984). Academic and cognitive interventions for LD adolescents: Part 1. *Journal of Learning Disabilities*, 17, 108-117.
- Dossey, J., Mullis, I., Lindquist, M., & Chambers, D. (1988). *The mathematics report card: Are we measuring up?* Princeton, NJ: ETS.

- Dupaul, G. J., & Henningson, P. N. (1993). Peer tutoring effects on the classroom performance of children with attention deficit disorder. *School Psychology Review*, 22, 134-143.
- Ehley, S. (1984). *Peer tutoring in the regular classroom: A guide for school psychologists*. Des Moines, IA, Department of Public Instruction, Special Education Division.
- Eiserman, W. D., Shisler, L., & Osguthorpe, R. T. (1987). Handicapped students as tutors: A description and integration of three years of research findings. *B.C. Journal of Special Education*, 11, 215-231.
- Fuchs, D., & Fuchs, L. S. (1988). Evaluation of the adaptive learning environments model. *Exceptional Children*, 55, 115-127.
- Fuchs, D., & Fuchs, W. (1994). Inclusive schools movement and the radicalization of special education reform. *Exceptional Children*, 60, 294-309.
- Fuchs, L. S., Fuchs, D., Hamlett, C. L., Phillips, N. B., & Bentz, J. (1994). Classwide curriculum-based measurement: Helping general educators meet the challenge of student diversity. *Exceptional Children*, 60, 518-537.
- Gerber, M., & Kauffman, J. M. (1981). Peer tutoring in academic settings. In P. S. Strain (Ed.) *The utilization of classroom peers as behavior change agents* (pp. 155-188). New York: Plenum Press.
- Goodlad, S., & Hirst, B. (1989). *Peer tutoring: A guide to learning by teaching*. New York: Nichols Publishing.
- Greenwood, C. R. (1991a). Longitudinal analysis of time, engagement, and achievement in at-risk versus non-risk students. *Exceptional Children*, 57, 521-535.
- Greenwood, C. R. (1991b). Classwide peer tutoring: Longitudinal effects on the reading, language, and mathematics achievement of at risk students. *Reading, Writing, and Learning Disabilities International*, 7, 105-123.
- Greenwood, C. R., Delquadri, J. C., & Carta, J. J. (1988). *Classwide peer tutoring*. Delray Beach, FL: Educational Achievement Systems.

- Greenwood, C. R., Delquadri, J. C., & Hall, R. V. (1984). Opportunity to respond and student academic performance. In W. L. Heward, T. E. Heron, D. S. Hill, & J. Trap-Porter (Eds.), *Focus on behavior analysis in education* (pp. 58-88). Columbus, OH: Charles E. Merrill.
- Greenwood, C. R., Delquadri, J. C., & Hall, R. V. (1989). Longitudinal effects of classwide peer tutoring. *Journal of Educational Psychology, 81*, 371-383.
- Greenwood, C. R., Dinwiddie, G., Bailey, V., Carta, J. J., Dorsey, D., Kohler, F. W., Nelson, C., Rotholz D., & Schulte, D. (1987). Field replication of classwide peer tutoring. *Journal of Applied Behavior Analysis, 20*, 151-160.
- Greenwood, C. R., Dinwiddie, G., Terry, B., Wade, L., Stanley, S. O., Thibadeau, S., & Delquadri, J. C. (1984). Teacher-versus peer-mediated instruction: An ecobehavioral analysis of achievement outcomes. *Journal of Applied Behavior Analysis, 17*, 521-538.
- Greenwood, C. R., Terry, B., Arreaga-Mayer, C., & Finney, R. (1992). The classwide peer tutoring program: Implementation factors moderating students' achievement. *Journal of Applied Behavior Analysis, 25*, 101-116.
- Grossen, B. (1992). The fundamental skills of higher order thinking. In D. Carnine & E. J. Kameenui (Eds.), *Higher order thinking: Designing curriculum for mainstreamed students* (pp. 157-182). Austin, TX: Pro-Ed.
- Hall, R. V., Delquadri, J., Greenwood, C. R., & Thurston, L. (1982). The importance of opportunity to respond in children's academic success. In E. B. Edgar, N. G. Haring, J. R. Jenkins, & C. G. Pious (Eds.), *Mentally handicapped children: Education and training* (pp. 107-140). Baltimore: University Park Press.
- Hallahan, D. P. (Ed). (1980). Teaching exceptional children to use cognitive strategies. *Exceptional Education Quarterly, 1*, 1-102.
- Hamblin, R. L., Hathaway, C., & Wodarski, J. (1971). Group contingencies, peer tutoring, and accelerating academic achievement. In E. A. Kamp & B. I. Hopkins (Eds.), *A new direction for education: Behavior analysis* (pp. 41-53). Lawrence, KS: University of Kansas Support and Development Center for Follow Through, Department of Human Development.

- Harper, G. F., Mallette, B., Maheady, L., & Brennan, G. (1993). Classwide student tutoring teams and direct instruction as a combined instructional program to teach generalizeable strategies for mathematics word problems. *Education and Treatment of Children*, 16, 115-134.
- Harper, G. F., Mallette, B., & Moore, J. (1991). Peer-mediated instruction: Teaching spelling to primary school children with mild disabilities. *Reading, Writing, and Learning Disabilities*, 7, 137-151.
- Hollowood, T. M., Salisbury, C. L., Rainforth, B., & Palombaro, M. M. (1994). Use of instructional time in classrooms serving students with and without severe disabilities. *Exceptional Children*, 61, 242-253.
- Hulse, S. H., Egeth, H., & Deese, J. (1980). *The psychology of learning*. New York: McGraw-Hill Book Company.
- Hutchinson, N. L. (1993). Effects of cognitive strategy instruction on algebra problem solving of adolescents with learning disabilities. *Learning Disability Quarterly*, 16, 34-63.
- Jenkins, J., & Jenkins, L. (1985). Peer tutoring in elementary and secondary programs. *Focus on Exceptional Children*, 17(6), 1-12.
- Jenkins, J. R., Mayhill, W. F., Peschka, C. M., & Jenkins, L. M. (1974). Comparing small group and tutorial instruction in resource groups. *Exceptional Children*, 40, 245-256.
- Jordan, L. (1995). *The effects of concrete to semiconcrete to abstract instruction on the acquisition and retention of fraction concepts and skills*. Unpublished manuscript, University of Florida, Gainesville.
- Kauffman, J. M. (1993). How we might achieve a radical reform of special education. *Exceptional Children*, 60, 6-16.
- Keppel, G. (1982). *Design and analysis: A researcher's handbook* (2nd ed.). Englewood Cliffs, NJ: Prentice-Hall.
- Maheady, L., & Harper, G. F. (1987). A class-wide peer tutoring program to improve the spelling test performance of low-income, third- and fourth-grade students. *Education and Treatment of Children*, 10, 120-133.

- Maheady, L., Harper, G. F., & Mallette, B. (1991). Peer-mediated instruction: A review of potential applications for special education. *Reading, Writing, and Learning Disabilities*, 7, 75-103.
- Maheady, L., Harper, G. F., Mallette B., & Winstanley, N. (1991). Training and implementation requirements associated with the use of a classwide peer tutoring system. *Education and Treatment of Children*, 14, 177-198.
- Maheady, L., Mallette, B., & Harper, G. F. (1991). Accommodating cultural, linguistic, and academic diversity: Some peer-mediated instructional options. *Preventing School Failure*, 36(1), 28-31.
- Maheady, L., Sacca, M. K., & Harper, G. F. (1987). Classwide student tutoring teams: The effects of peer-mediated instruction on the academic performance of secondary mainstreamed students. *The Journal of Special Education*, 21(3), 107-121.
- Maheady, L., Sacca, M. K., & Harper, G. F. (1988). Classwide peer tutoring with mildly handicapped high school students. *Exceptional Children*, 55, 52-59.
- Mallette B., Harper, G. F., Maheady, L., & Dempsey, M. (1991). Retention of spelling words acquired using a peer-mediated instructional procedure. *Education and Training in Mental Retardation*, 26, 156-164.
- Mathes, P. G., Fuchs, D., Fuchs, L. S., Henley, A. M., & Sanders, A. (1994). Increasing strategic reading practice with Peabody classwide peer tutoring. *Learning Disabilities Research & Practice*, 9, 44-48.
- Mayer, R. E. (1993). Understanding individual differences mathematical problem solving: Towards a research agenda. *Learning Disability Quarterly*, 16, 2-5.
- McGee, C. S., Kauffman, J. M., & Nussen, J. L. (1977). Children as therapeutic change agents: Reinforcement intervention paradigms. *Review of Educational Research*, 47, 451-477.
- McIntosh, R., Vaughn, S., Schumm, J. S., Haager, D., & Lee, O. (1993). Observations of students with learning disabilities in general education classrooms. *Exceptional Children*, 60, 249-261.

- Mcleskey, J., & Pacchiano, D. (1994). Mainstreaming students with learning disabilities: Are we making progress? *Exceptional Children*, 60, 508-517.
- Mercer, C. D. (1992). *Students with learning disabilities* (4th ed.). Columbus, OH: Macmillan Publishing Company.
- Mercer, C. D., Enright, B., & Tharin, M. (1994). *Solving division equations: An algebra program for teaching students with learning problems*. Unpublished manuscript.
- Mercer, C. D. & Mercer, A. R. (1993). *Teaching students with learning problems* (4th ed.). New York: Macmillan Publishing Company.
- Montague, M., & Applegate, B. (1993). Middle school students' mathematical problem solving: An analysis of think-aloud protocols. *Learning Disability Quarterly*, 16, 19-32.
- Montague, M., & Bos, C. S. (1986). The effect of cognitive strategy training on verbal math problem-solving performance of learning disabled adolescents. *Journal of Learning Disabilities*, 19, 26-33.
- Myers, K., Travers, R., & Sanford, M. (1965). Learning and reinforcement in student pairs. *Journal of Educational Psychology*, 56, 67-72.
- National Association of State Boards of Education. (1992). *Winner's all: A call for inclusive schools*. Alexandria, VA: Author.
- Nelson, C. M., & Polsgrove, L. (1984). Behavior analysis in special education: White rabbit of white elephant? *Remedial and Special Education*, 5(4), 6-17.
- Osguthorpe, R. T., & Scruggs, T. E. (1986). Special education students as tutors: A review and analysis. *Remedial and Special Education*, 7(4), 15-25.
- Osguthorpe, R. T., & Scruggs, T. E. (1990). Special education students as tutors: A review and analysis. In S. Goodlad & B. Hirst (Eds.), *Peer tutoring: A guide to learning by teaching* (pp. 176-193). New York: Nichols Publishing.

- Peterson, S. K. (1987/88). The concrete to abstract mathematical instructional sequence with learning disabled students (Doctoral dissertation, University of Florida, 1987/88). *Dissertation Abstracts International*, 38, 2040A.
- Pinnell, G. S., DeFord, D. E., & Lyons, C. A. (1984). Reconceptualizing support services for classroom teachers: Implications for teacher education. *Journal of Teacher Education*, 35, 48-55.
- Reynolds, M. C. (1988). Reaction to the JLD special education series on the Regular Education Initiative. *Journal of Learning Disabilities*, 21, 352-356.
- Reynolds, M. C., Wang, M. C., & Walberg, H. J. (1987). The necessary restructuring of special and regular education. *Exceptional Children*, 53, 391-398.
- Rosenshine, B. V., & Berliner, D. C. (1978). Academic engaged time. *British Journal of Teacher Education*, 4(4), 3-16.
- Rosenshine, B., & Stevens, R. (1986). Teaching functions. In M. C. Wittrock (Ed.), *The handbook of research on teaching* (pp. 376-391). New York: Macmillan.
- Schumm, J. S., Vaughn, S., Haager, D., McDowell, J., Rothlein, L., & Saumell, L. (1995). General education teacher planning: What can students with learning disabilities expect? *Exceptional Children*, 61, 335-352.
- Scruggs, T. E., Mastropieri, M. A., & Richter, L. (1985). Peer tutoring with behaviorally disordered students: Social and academic benefits. *Behavioral Disorders*, 11, 283-294.
- Scruggs, T. E., & Richter, L. (1985). Tutoring learning disabled students: A critical review. *Learning Disability Quarterly*, 8, 286-298.
- Shafer, M. S., Egel, A. L., & Neef, N. A. (1984). Training mildly handicapped peers to facilitate changes in the social interaction skills of autistic children. *Journal of Applied Behavior Analysis*, 17, 461-476.
- Skinner, B. F. (1974). *About behaviorism*. New York: Alfred A. Knopf.
- Slavin, R. E. (1983). *Cooperative learning*. New York: Longman Inc.

- Slavin, R. E. (1992). *Research methods in education*. Needham Heights, MA: Allyn and Bacon.
- Smith, D. D. (1981). *Teaching the learning disabled*. Englewood Cliffs, NJ: Prentice Hall.
- Smith, D. D., & Lovitt, T. C. (1976). The differential effects of reinforcement contingencies on arithmetic performance. *Journal of Learning Disabilities*, 9, 21-29.
- Sprick, R. S. (1986). *Solutions to elementary discipline programs* (Cassette tapes). Eugene, OR: Teaching Strategies.
- Sprinthall, R. C., & Sprinthall, N. A. (1977). *Educational psychology: A developmental approach*. Philippines: Addison-Wesley Publishing Company, Inc.
- Stainback, S., & Stainback, W. (1992). *Curriculum considerations in inclusive classrooms: Facilitating learning for all students*. Baltimore: Paul Brookes.
- Stanley, S. O., & Greenwood, C. R. (1983). How much "opportunity to respond" does the minority disadvantaged student receive in school? *Exceptional Children*, 49, 370-373.
- Stevens, R. J., Madden, N. A., Slavin, R. E., & Farnish, A. M. (1987). Cooperative integrated reading and composition: Two field experiments. *Reading Research Quarterly*, 22, 433-454.
- Stokes, T. F., & Baer, D. M. (1977). An implicit technology of genralization. *Journal of Applied Behavior Analysis*, 10, 349-367.
- Strike, K. A. (1975). The logic of learning by discovery. *Review of Educational Research*, 45, 461-483.
- Top, B. L. (1984). Handicapped children as tutors: The effects of cross-age, reverse-role tutoring on self-esteem and reading achievement. *Dissertation Abstracts International*, 46, 886. (University Microfilms No. 85-05, 580)
- Torgesen, J., & Kail, R. (1980). Memory processes in exceptional children. In B.K. Keogh (Ed.), *Advances in special education: Volume I. Basic constructs and theoretical orientations, a research annual* (pp. 115-153). Greenwich, CT: JAI Press.

- Vacc, N. N., & Cannon, S. J. (1991). Cross-age tutoring in mathematics: Sixth graders helping students who are moderately handicapped. *Education and Training in Mental Retardation*, 26, 89-97.
- Vygotsky, L. S. (1978). *Mind society: The development of higher psychological processes*. Cambridge, MA: Harvard University Press.
- Wang, M. C. (1984). An investigation of the implementation and effects of a full-time mainstreaming program. *Remedial and Special Education*, 5(6), 21-32.
- Wang, M. C., & Zollers, N. J. (1990). Adaptive instruction: An alternative service delivery approach. *Remedial and Special Education*, 11(1), 7-21.
- Warger, C. L. (1991, December). Peer tutoring: When working together is better than working alone. *Research & Resources on Special Education*. (Available from EERIC/OSEP Special Project, ERIC Clearinghouse on Handicapped and Gifted Children, The Council for Exceptional Children, 1920 Association Drive, Reston, VA 22091)
- Watson, J. B. (1957). *Behaviorism*. Chicago: The University of Chicago Press.
- Wildman, R. W., II, & Wildman, R. W. (1975). The genralization of behavior modification procedures: A review-with special emphasis on classroom applications. *Psychology in the Schools*, 12, 432-448.
- Zawaiza, T. R. W., & Gerber, M. M. (1993). Effects of explicit instruction on math word-problem solving by community college students with learning disabilities. *Learning Disability Quarterly*, 16, 64-79.

BIOGRAPHICAL SKETCH

David Allsopp was born in Ocala, Florida, on September 6, 1961. He graduated from Ocala Forest High School in 1979. David received his B.A. in psychology at Furman University in 1983 and his Master of Education degree in special education-learning disabilities from the University of Florida in 1990. After receiving his Master of Education degree, David began work on his doctorate in special education at the University of Florida.

David taught in the Marion County School District for seven years as a teacher of students with mild and moderate disabilities. His first two years of teaching occurred at Osceola Middle School in Ocala, Florida. David was most fortunate to teach with a wonderful teacher in the learning disabilities program named Danelle Bartell. Ms. Bartell was David's sixth-grade math and English teacher. Ms. Bartell was an inspiration to him as a middle school student and even more so as a mentor. Some of his fondest memories are as an excited but very naive beginning teacher in the "Osceola Hilton." After two years, David moved to Fort King Middle School to help build a beginning program for students with severe learning disabilities. With the invaluable help of Nancy Britt, his teaching assistant and "counselor," and his enriching students, David was able to grow as a teacher and

person. In 1991 David was fortunate enough to be honored as "Teacher of the Year" for Fort King Middle School, for the Marion County School District, and for the Crown Region of Florida. In addition, David was honored as "Young Educator of the Year" for the State of Florida by the Florida Jaycees.

While completing his doctoral studies at the University of Florida, David served as graduate teaching assistant, graduate research assistant, and intern supervisor in the Department of Special Education, College of Education. In addition, David served as editorial assistant to the journal Teacher Education and Special Education, as a member of the University of Florida Institutional Review Board, as President of the Special Education Association of Graduate Students, and as a research associate for the Multidisciplinary Diagnostic and Training Program in the College of Education.

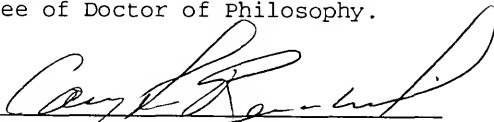
David is a member of the Council for Exceptional Children, including the Division of Learning Disabilities and the Teacher Education Division, the Learning Disabilities Association, and the Association for Supervision and Curriculum Development. He is also a member of Marion County's Golden Apple Academy and the Omicron Delta Kappa and Psi Chi honor societies. David plans to continue his work in teacher preparation and to continue his research in interventions for students with mild disabilities and students who are at risk of academic failure.

I certify that I have read this study and that in my opinion it conforms to accepted standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.



Cecil D. Mercer, Chair
Professor of Special Education

I certify that I have read this study and that in my opinion it conforms to accepted standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.



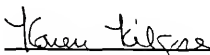
Cary L. Reichard
Professor of Special Education

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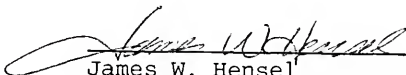
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Assistant Professor of Special
Education

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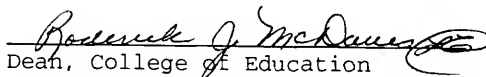
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I certify that I have read this study and that in my opinion it conforms to accepted standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.


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Professor of Educational Leadership

This dissertation was submitted to the Graduate Faculty of the College of Education and to the Graduate School and was accepted as partial fulfillment of the requirements for the degree of Doctor of Philosophy.

May 1995


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